Examining the Effects of Conducting Behavior-Based Safety Observations

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EXAMINING THE EFFECTS OF CONDUCTING BEHAVIOR-BASED SAFETY OBSERVATIONS

by

Joseph R. Sasson

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EXAMINING THE EFFECTS OF CONDUCTING BEHAVIOR-BASED SAFETY OBSERVATIONS

Joseph R. Sasson, M.A.

Western Michigan University, 2002

Eleven computer terminal operators participated in a series of interventions aimed at increasing safe ergonomic performance. All participants received ergonomics training and performance feedback, and approximately one half of the participants conducted observations for safe behavior. Conducting observations of safety-related behavior is a critical component of the Behavior-Based Safety (BBS) process, yet few researchers have studied the effects of conducting observations on the behavior of the observer. This study sought to examine the effects of conducting BBS observations on the safe performance of the observer in an applied setting. A multiple baseline across participants design was used to assess the effects of the interventions in two departments of a large mid-western hospital. All participants increased performance over baseline conditions, and most participants maintained higher levels of performance at a four-month follow-up evaluation. The possible behavioral mechanisms responsible for performance increases, and the implications of these findings are discussed in detail. Future research in this area is suggested, and these recommendations focus on several aspects of verbal-behavior as directions for future study.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>ii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Background Information and Literature Review</td>
<td>2</td>
</tr>
<tr>
<td>Behavior-based Safety</td>
<td>4</td>
</tr>
<tr>
<td>Musculoskeletal Disorders (MSDs)</td>
<td>9</td>
</tr>
<tr>
<td>Performance-Based Training</td>
<td>12</td>
</tr>
<tr>
<td>Conducting Observations</td>
<td>14</td>
</tr>
<tr>
<td>Performance Feedback</td>
<td>17</td>
</tr>
<tr>
<td>Summary</td>
<td>18</td>
</tr>
<tr>
<td>METHOD</td>
<td>20</td>
</tr>
<tr>
<td>Setting and Participants</td>
<td>20</td>
</tr>
<tr>
<td>Independent Variables</td>
<td>21</td>
</tr>
<tr>
<td>Dependent Variables</td>
<td>23</td>
</tr>
<tr>
<td>Interobserver Agreement</td>
<td>25</td>
</tr>
<tr>
<td>Procedures</td>
<td>25</td>
</tr>
<tr>
<td>RESULTS</td>
<td>33</td>
</tr>
<tr>
<td>General Interpretation</td>
<td>33</td>
</tr>
<tr>
<td>Participant 1</td>
<td>33</td>
</tr>
<tr>
<td>Participant 2</td>
<td>35</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Participant 3</td>
<td>37</td>
</tr>
<tr>
<td>Participant 4</td>
<td>39</td>
</tr>
<tr>
<td>Participant 5</td>
<td>41</td>
</tr>
<tr>
<td>Participant 6</td>
<td>43</td>
</tr>
<tr>
<td>Participant 7</td>
<td>45</td>
</tr>
<tr>
<td>Participant 8</td>
<td>47</td>
</tr>
<tr>
<td>Participant 9</td>
<td>49</td>
</tr>
<tr>
<td>Participant 10</td>
<td>51</td>
</tr>
<tr>
<td>Participant 11</td>
<td>53</td>
</tr>
<tr>
<td>Overall Safety</td>
<td>55</td>
</tr>
<tr>
<td>Accuracy of Observations</td>
<td>58</td>
</tr>
<tr>
<td>Participant Exit Interview Responses</td>
<td>61</td>
</tr>
<tr>
<td>Impact of Historical MSDs on Behavior Change</td>
<td>67</td>
</tr>
<tr>
<td>Interobserver Agreement</td>
<td>69</td>
</tr>
<tr>
<td>DISCUSSION</td>
<td>70</td>
</tr>
<tr>
<td>Baseline Performance</td>
<td>70</td>
</tr>
<tr>
<td>Effects of Information</td>
<td>72</td>
</tr>
<tr>
<td>Effects of Conducting Observations</td>
<td>72</td>
</tr>
<tr>
<td>Effects of Receiving Feedback</td>
<td>72</td>
</tr>
<tr>
<td>Effects of Conducting Observations in Conjunction with Feedback</td>
<td>73</td>
</tr>
<tr>
<td>Follow-up Performance</td>
<td>73</td>
</tr>
</tbody>
</table>
Table of Contents—continued

Relationship Between Accuracy and Safe Performance ........................................... 74
Possible Behavioral Functions ................................................................................ 76
Post-Experiment Survey ......................................................................................... 84
Modeling ................................................................................................................. 90
Impact of Historical MSDs on Behavior Change ................................................... 90
Strengths and Weaknesses of the Study ................................................................. 91
Future Research and Applied Implications ............................................................. 96
Closing Comments .................................................................................................. 97

APPENDICES

A. Ergonomic Behaviors Training ........................................................................ 98
B. Behavior Recording Form .............................................................................. 102
C. Ergonomic Behaviors Feedback Form ........................................................... 104
D. Ergonomic Behaviors Quiz ........................................................................... 106
E. Informed Consent Documentation ................................................................. 108
F. Debriefing Script ......................................................................................... 113
G. Debriefing Questions ................................................................................... 115
H. Site Approval Letter ..................................................................................... 119
I. Protocol Clearance from the Human Subjects Institutional Review Board .... 121

BIBLIOGRAPHY .................................................................................................. 123
LIST OF TABLES

1. Interpreting the Size of a Correlation Coefficient.......................... 75
2. Analysis of the At-Risk Performance of Back / Shoulder Position ........ 80
3. Analysis of the Safe Performance of Back / Shoulder Position.............. 81
4. Analysis of the At-Risk Performance of Foot Position........................ 82
5. Analysis of the Safe Performance of Foot Position............................ 83
LIST OF FIGURES

1. Data for Participant 1. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 34

2. Data for Participant 2. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 36

3. Data for Participant 3. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 38

4. Data for Participant 4. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 40

5. Data for Participant 5. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 42

6. Data for Participant 6. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 44

7. Data for Participant 7. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 46

8. Data for Participant 8. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 48

9. Data for Participant 9. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 50

10. Data for Participant 10. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................ 52
List of Figures—continued

11. Data for Participant 11. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored ............................................................................................................. 54

12. Overall Percent Safe Scores for Non-Observer Participants. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored, Averaged Across All Behaviors for the Non-Observer Participants ........................................................................ 56

13. Overall Percent Safe Scores for Participant Observers. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored, Averaged Across All Behaviors for the Participant Observers ........................................................................ 57

14. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 2 ....................................................................................................................... 58

15. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 5 ....................................................................................................................... 59

16. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 6 ....................................................................................................................... 59

17. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 8 ....................................................................................................................... 60

18. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 9 ....................................................................................................................... 60

19. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 10 ....................................................................................................................... 61
INTRODUCTION

The primary purpose of this research was to examine the effects of conducting observations as a part of the behavior-based safety (BBS) process. The research was conducted in both the patient accounting and the patient scheduling departments of a large hospital. Employees in the aforementioned departments use keyboards to enter data as a primary function of their job and perform their jobs at computer-oriented workstations for their entire shift, which places them at risk for various musculoskeletal disorders (MSDs) (e.g., carpal tunnel syndrome). Employees in these departments had not been given any formal ergonomics training prior to this study and several employees had filed workers compensation claims for work-related MSDs. As a part of BBS programs designed to improve ergonomic behavior, data collectors often use direct observation methods and checklists to assess levels of safety. Alvero and Austin (in press) conducted a laboratory study to examine how conducting BBS observations would affect the safe performance of the observer. The current study was designed to replicate and extend the findings of Alvero and Austin (in press) by utilizing similar methodology in an applied setting.

Each year the number of work-related MSDs reported continues to rise. Measures taken to improve the behaviors that lead to MSDs would result in clear financial gain for employers, as well as clear health benefits for employees. The dependent variables targeted in the current study were behaviors that have been shown to be major contributors to many types of MSDs. Therefore, increased performance on the target behaviors would mitigate the likelihood of the development of some MSDs and increase
the comfort and health of the participant. In the event of substantial behavior change, cost savings may also be achieved by the hospital, which may experience a resultant reduction in workers compensation claims over the long term.

Background Information and Literature Review

Every year in the United States thousands of employees report work-related musculoskeletal disorders (MSDs) (Occupational Safety and Health Administration [OSHA], 1999a; OSHA, 1999b). MSDs have also been referred to as repetitive stress injuries, (CTD News, 2000), cumulative trauma disorders (Blair & Bear-Lehman, 1987; Blake McCann & Sulzer-Azaroff, 1996; Kroemer, 1989), and repetitive strain injuries (New York Committee for Occupational Safety and Health [NYCOSH], 2000). According to OSHA, MSDs account for 34% of all lost workday injuries and illnesses and there were more than 670,000 lost workdays due to MSDs in 1996 alone (OSHA, 1999a; OSHA 1999b). In 1999 there were approximately 247,000 MSDs reported, and at an average cost of $11,420 per claim, the annual medical costs alone were near $3 billion (NSC, 2001). Furthermore, these injuries cost business $20 billion in workers’ compensation costs and the indirect costs may run as high $45 to $60 billion each year (OSHA, 1999a; OSHA 1999b; United States Department of Labor [USDOL], 1998).

Aside from the obvious monetary consequences to the business, workers affected by these injuries may ultimately be faced with a crippling disability; a disability that may prevent them from doing simple everyday tasks such as combing their hair, picking up a baby, or reaching for a book on a high shelf (OSHA, 1999b). Considering some of the changes that have occurred in the work environment over the last 20 years, such as the addition of computers and an increase of time spent sitting at desks, it is not surprising that more
people are experiencing MSDs than ever before. The number of people with computers on their desks at work has been estimated at nearly 50 million (Karp, 2000), and the use of a computer is a major contributing factor to people spending increasing periods of time in a static posture. According to an in depth analysis of over 600 epidemiological studies reviewed by the National Institute for Occupational Safety and Health (NIOSH) (2000), and the National Academy of Sciences (NAS), there is sufficient evidence to suggest a causal relationship between highly repetitive work (i.e., using a computer) and neck and neck/shoulder MSDs (USDOL, 1998). According to NIOSH (2000), there is also strong evidence that persons with static or extreme working postures involving the neck/shoulder muscles, such as those involved in prolonged periods of computer usage, are at increased risk for neck/shoulder MSDs.

Many researchers, consultants, and organizations attempt to reduce injuries by either altering the work environment (i.e., changing equipment) to eliminate potential risk factors, or by altering the behavior of employees in the environment (i.e., changing behavior so that people perform their jobs more safely). In the majority of cases equipment changes constitute a necessary, but not sufficient, improvement for establishing safe performance. In other words, altering equipment may enable safe performance in the workplace, but it does not guarantee that it will occur. Take the example of an ergonomically designed chair. Although the chair may be adjustable in every possible way to support the users height, lumbar, or desired tilt, the worker may still lean against the back of the chair, or sit with legs crossed. In order for behavior change to occur reliably over time, employees need adequate equipment, controls, knowledge and skills, and motivation to behave safely. Focusing on the behavior of employees in order to increase safety performance is the foundation of the behavior-based
safety (BBS) process. Studies show the effectiveness of the BBS process in many settings including manufacturing (for a review, see Grindle, Dickinson, & Boettcher, 2000; for an example, see Sulzer-Azaroff, Loafman, Merante, & Hlavacek, 1990), construction (Austin, Kessler, Riccobono, & Bailey, 1996), food preparation (Geller, Eason, Phillips, & Pierson, 1980), driving (Ludwig & Geller, 1997), mining (Fox, Hopkins, & Anger, 1987), and more. Studies have also demonstrated reductions of unsafe work behavior in attempts to reduce the number of MSDs (e.g., Blake McCann & Sulzer-Azaroff, 1996). The BBS process has demonstrated success at reducing workplace injuries in a number of domains, and in a review of 33 articles that reported incidence rates as a dependent variable, 32 of the articles reported a reduction in injuries due to BBS programs (Sulzer-Azaroff & Austin, 2000). This reported reduction in injuries spares workers immeasurable amounts of pain and suffering, and has the added benefit of cost savings (e.g., Sulzer-Azaroff et al., 1990).

Behavior-based Safety

Sulzer-Azaroff and Austin (2000) define behavior-based safety (BBS) as, “...a systematic approach to promoting behavior supportive of injury prevention” (p. 19). Daniels (1989) defines performance management as, “A systematic, data-oriented approach to managing people at work that relies on positive reinforcement as the major way to maximizing performance” (p. 4). The BBS process employs the principles of applied behavior analysis (Baer, Wolf, & Risley, 1968) and performance management to achieve its goals of increased occupational and personal safety. Although the fundamental concepts of BBS remain constant, an application can vary in form with each location or implementation. As Sulzer-Azaroff and Austin stated, “Depending on an organization’s needs, resources, and objectives, each system will have uniquely
customized features” (p. 20). Whatever customizations may occur, Sulzer-Azaroff and Austin have identified the key elements of an effective BBS package as: 1) Identifying (or targeting) behaviors that impact safety; 2) Defining those behaviors precisely enough to measure them reliably; 3) Developing and implementing mechanisms for measuring those behaviors in order to determine their current status and setting reasonable goals for their improvement; 4) Providing feedback; and 5) Reinforcing progress toward goal attainment.

Sulzer-Azaroff, Loafman, Merante, and Hlavacek (1990) used a behavior-based intervention to reduce the number of “OSHA” recordables and lost time injuries in a large industrial plant. OSHA recordables were defined as: “any injury referred for medical treatment beyond first aid” (p.110). Lost time injuries were defined as: “any injury leading to at least one day off the job” (p. 110). The authors described an intervention consisting of a combination of feedback, reinforcement, and goal setting. Behavioral observations were conducted by the researchers to assess the increases in safety performance. The study showed an increase in safe behavior, a decrease in both OSHA recordables and lost time injuries, and a conservative estimate of a first year net savings of $55,500. The Sulzer-Azaroff et al. study illustrates the effectiveness of behavior-based interventions that employ package interventions consisting of feedback, reinforcement, and goal-setting while illustrating that attempts to reduce workplace injuries using behavioral methods can result in great benefits to a company and its employees.

Researchers have also demonstrated the effects of behavioral techniques to address other significant health concerns. It is estimated that over 90% of food-borne illness is attributed to human behavior (Government-University-Industry Research Roundtable [GUIRR], 1999). To address this issue Geller, Eason, Phillips, and Pierson
(1980) used an ABACADA design to evaluate the effects of multiple interventions on the sanitation behavior of food preparation employees. In an attempt to reduce the collection of microorganisms on employees’ hands, three interventions were established to increase hand washing after employees engaged in behavior that was designated as high risk for collecting microorganisms. The researchers compared three interventions, including: 1) Hand watching – telling employees that their sanitation behaviors were going to be videotaped and having visual-recording equipment in full view of the employees; 2) Sanitation training; and, 3) Feedback on microorganism collecting and hand washing behavior sequences. An increase in safe behavior was observed in all intervention conditions, with the feedback intervention resulting in the greatest performance improvement. In the training condition, a significant increase in hand washing occurred only on the day following the delivery of the sanitation training. This observed lack of maintenance is a common result of training interventions. During baseline hand washing occurred at a mean rate of 2.1 occurrences per day and increased to 5 occurrences per day during the feedback condition. The study shows that behavioral procedures can effectively increase the frequency of hand washing under necessary conditions, thereby increasing sanitation in a kitchen environment.

Fox, Hopkins, and Anger (1987) implemented a token-economy system at a large open-pit mine in the northern portion of the United States. The authors evaluated, over the course of more than 10 years, two implementations of behavior-based safety. The two dependent variables were: 1) the number of job related injuries that caused a worker to be absent from work one or more days; and, 2) the total number of days absent from work due to injuries. Direct costs of injuries were also monitored and included costs for compensation insurance, medical care for insured workers, and costs of repairing
damaged equipment. Cost figures were proportioned to the yearly number of person-hours worked and adjusted for inflation. The index of injury severity – the total number of days absent from work due to injuries - showed an 89% decrease at Site A, and a 98% decrease at Site B. The index of injury frequency – the number of job related injuries that caused a worker to be absent one or more days – showed an 85% decrease at Site A, and a 68% decrease at Site B. The direct costs of injuries were also reduced dramatically, and produced an annual savings of approximately $265,000 (at a cost: benefit ratio of approximately 1:25) at Site A and $325,000 (at a cost: benefit ratio of approximately 1:27) at Site B. Perhaps the most significant contribution of this study is the longevity demonstrated by the BBS implementations. By decreasing both injury rates and the costs associated with those injuries, the BBS process maintained both owner and employee support for many years. When executed correctly, the BBS process becomes a part of an organization’s culture and remains for the life of the organization. In this case, Site A continued to use their BBS program for 12 years until mining ceased at the site due to resource depletion. As of the last published report (in 1987), Site B had been using the plan for 11 years and was still using BBS as a way to eliminate accidents and injuries.

Austin, Kessler, Riccobono, and Bailey (1996) conducted a study with a roofing crew to demonstrate that increases in safety do not have to come at the expense of decreased productivity. Using performance management (Daniels, 1989) techniques and behavior-based safety, the researchers conducted two simultaneous studies with the same group of participants. The first study focused on increasing the productivity of the workers. Researchers calculated the actual labor costs as a percentage of estimated labor costs for the project. The estimator of the roofing company calculated estimated labor costs six months before the study had begun. The researchers used a package
intervention consisting of: (1) Small tangible reinforcers (i.e., soft drinks or fruit) based on goal achievement; (2) Performance contingent lunches (free lunches for meeting larger goals); (3) Daily feedback on the monetary bonus earned to date (participants were part of a profit sharing plan for this particular project and earned their share of 40% of the money saved); and, (4) A weekly bonus check with feedback (bonus checks were provided separately from wage checks, and performance graphs were included with the weekly bonus checks). During the baseline condition the mean labor cost was 141% of the estimated labor cost and during the two baseline probe conditions the mean labor costs were 117.6% and 184.6% of the estimated labor costs. When the workers were provided with incentive pay, small tangible reinforcers, and graphed performance feedback the mean labor cost was reduced to 81% of the estimated labor cost with a range of 43%-105% (100% represents performance equal to the estimated costs; below 100% indicated that actual costs were lower than estimated costs).

The second experiment, which was conducted in conjunction with the one described above, focused on the safe behavior of the roofers. Safety targets were identified on two separate checklists, one checklist for safety targets on the roof, and one checklist for safety targets on the ground. Workers were trained to identify the safety targets being used as dependent variables, and the foreman at the work site delivered performance feedback to the workers on a daily basis. Roofers could earn paid time off and small tangible reinforcers when the group as a whole achieved 80% safe for safety measures on the ground and on the roof. During the baseline condition the safety score averaged 51% on the ground and 55% on the roof. During the feedback and reinforcement condition the safety score averaged 90% on the ground and 95% on the roof.
Many people believe that focusing on safety related behaviors will result in decreased worker productivity. Others have concerns with encouraging productivity at the expense of creating safety problems in the workplace. Austin, Kessler, Riccobono and Bailey (1996) showed that well designed BBS and performance management systems are compatible, and when used together they can create an effective safety and efficiency solution.

Musculoskeletal Disorders (MSDs)

On January 16th, 2001 OSHA’s ergonomics standard took effect, mandating that employers take measures to ensure they are providing employees with ergonomically sound work environments. Unfortunately, within 45 days of taking effect and the beginning of a new Republican administration, the standards were overturned, and were no longer applicable. Sandy Smith, the managing editor of Safety Online, has said that these standards would have affected over 100 million workers and could have saved 4.6 million people from experiencing MSDs over the next 10 years, resulting in a national savings of $9.1 billion each year (Smith, 2001a). Smith also quoted Gerald W. McEntee, president of the American Federation of State, County and Municipal Employees (AFSME), who claimed that the NAS analysis of over 600 studies (USDOL, 1998) “confirms what millions of American workers have learned the hard way: repetitive motion causes workplace injuries” (Smith, 2001b, Support section, ¶1). The NAS stated that “…a rapid work pace, monotonous work, low job satisfaction, little decision-making power, and high levels of stress are associated with back disorders” (Smith, 2001b, Relationship section, ¶1). Although partially attributing MSDs to psychosocial factors in the workplace (i.e., stress), the NAS recognized the leverage that can be gained over MSDs by utilizing the principles of human behavior. At the 1999 Government-
University-Industry Research Roundtable (GUIRR) held by the NAS on an annual basis, the contributions of the behavioral sciences were duly noted. The GUIRR noted that engineers say that they are “… continually surprised by the behavior of operators and users, which can produce accidents with heavy costs. They tend to blame “human error” in such cases. Human factors experts say that most could be avoided by better integrating behavioral knowledge into engineering, operations, and training” (GUIRR, 1999, Making products safer section, ¶4). The GUIRR also noted that although social and behavioral scientists have much to contribute to industry and society, they are rarely in positions to influence design or business strategy and are therefore automatically limited in the impact they can achieve. The GUIRR made recommendations for cross training, suggesting that the few outstanding individuals with expertise in bridging behavioral backgrounds with industry problems and methods have demonstrated themselves as industry leaders and are able to make decisions that go beyond current situation “quick fixes”, and that industry can help to build this expertise by offering internship programs to students in the field.

Dennis Downing, president of Future Industrial Technologies (F.I.T.), has achieved such cross training. Downing has coined a term for what many would refer to as BBS. He calls it “Bionomics – …how to correctly manage your body while working; ‘bio’ meaning life (body) and ‘nomics,’ meaning to manage” (Safety Online, 2001, ¶2). The word “bio” replaces the word “ergo” to shift the emphasis from the work -“ergo”- to the body -“bio”. Downing realized that although his company was giving correct ergonomics training, the content of their training was being applied incorrectly or not at all, and there was no reduction in workers’ compensation costs with his clients. Downing began to shift the focus of his training to human behavior, and felt that there must be a “doingness” to training, and that the learner must engage in some task-related activity
rather than simply watching a video or listening to a lecturer. Downings’ practices of actively involving learners in training activities is also supported by training experts such as Brethower and Smalley (1998) who said that having learners engage in the task is an essential component of effective training and will increase the transfer of training to the actual work environment. According to Downing, since his shift in focus, his programs have been able to achieve consistent, sustainable reductions in injuries (Safety Online, 2001). It appears as though business and industry are just coming to realize what many academics in the behavioral community have long since known – all of the training and system changes that are implemented will have little impact if they do not effectively change the worker’s behavior.

In a scientific attempt to reduce MSDs using behavioral methods, Blake McCann and Sulzer-Azaroff (1996) used a feedback, reinforcement, and goal setting procedure to increase correct posture and hand-wrist position of participants engaging in keyboarding tasks. Using a multiple baseline across participants design, consisting of a baseline, training and self-monitoring, and treatment package intervention (feedback, reinforcement, and goal setting), performance rose to near maximal levels during the training condition. During this training condition the participants did not receive any additional feedback on their performance or information on past performance, and levels of safe performance increased across all target behaviors. The results of the study suggest that self-monitoring in conjunction with training can be effective in reducing unwanted behaviors and increasing ergonomically correct behaviors.

Alvero and Austin (in press) conducted a laboratory study to improve both postural behaviors and wrist position of computer terminal operators. Independent variables included: (a) information on ergonomic behavior; and, (b) observation and
scoring of videos depicting a confederate engaged in office work. After observing and scoring a video of a confederate engaging in common office tasks (i.e., typing, talking on the phone, picking up boxes), the participant entered a simulated office environment to engage in tasks that were identical to the ones the confederate had been performing in the video. Although slight performance gains were observed when information on ergonomic behavior was distributed to the participants, more significant gains were produced when participants observed and scored a video of a confederate engaging in the same tasks. These participants received no feedback about their performance and yet safe performance increased dramatically, showing that receiving brief training in observing safe behaviors, and conducting observations of the behavior of others, influenced the performance of the observer in a simulated office setting. Target behaviors in this study were widely accepted as related to development of MSDs.

Performance-Based Training

For years training has been a component of performance improvement strategies across all fields and disciplines. Simply put, how can a person improve if they do not know what they are supposed to be doing? One of behavioral technology’s great assets is the knowledge of adult learning mechanisms that enable it to create more effective instruction. Brethower and Smalley (1998) dictate a three-step process for providing instruction: Guided observation, guided practice, and a demonstration of mastery. This approach is referred to as Performance-Based Training.

Guided observation is performing the task to be taught while learners observe what the trainer is doing. In this phase the trainer explains what steps are taken, why the steps are taken, and how to progress through each step of the task. Important task information should be taught to the learner in this phase and once the learner has
observed the task being performed a sufficient number of times the trainer moves the learner into the guided practice phase.

During guided practice the learner performs the task under the supervision of the trainer. The trainer assumes the role of coach and provides feedback to the learner to help him or her improve. Guided practice continues until the learner appears ready to begin the job. It is not uncommon to require learners to meet some established criteria before completing the guided practice phase. At the end of guided practice a learner is ready to begin using the skills(s) he or she learned on the job.

Demonstration of mastery is something that is expected of performers after engaging in the newly taught tasks for some period of time. Depending on the task taught, a demonstration of mastery could be expected after a day, a month, a year, or many years on the job. Similar to completing guided practice, achieving a demonstration of mastery is also defined by meeting some predetermined criteria.

Other components of Performance-Based Training include evaluating learnability, utility, cost-effectiveness, and organizational impact, the presentation of examples and non-examples of behavior, and the use of job aids. According to Brethower and Smalley (1998) Performance-Based Training is a behaviorally sound, efficient, effective, and cost-effective method of training new tasks.

Conducting Observations

Conducting observations is an essential component of applied behavioral research. Although many studies have examined the reactivity experienced as a function of being observed (e.g., Gittelsohn, Shankar, West, Ram, & Gnywali, 1997; Orlowska, 1990; Kirmeyer, 1985), few have studied the behavioral effects on those who conduct observations. In all behavioral research a primary interest is the performance of the
participants exposed to the independent variable(s). Self-monitoring procedures represent a special case of this approach wherein the behavior of participants is both the dependent and independent variable. Outside of studying self-monitoring procedures (i.e., when participants observe their own behavior), behavioral research has not expressed great concern with the effects of conducting observations on the behavior of the observer. In general terms, the phenomena of interest in research on self-monitoring appear analogous to the effects of the present study: The effects of observation on the observer.

Studies have shown that self-monitoring used alone, or in conjunction with antecedents and/or consequences, can be an effective intervention, or intervention component (Hayes & Nelson, 1983; Lam, Cole, Shapiro, & Bambara, 1994; Wood, Murdock, Cronin, Dawson, & Kirby, 1998). Lam et al. used a self-monitoring procedure to increase the on-task behavior of 3 males (age 13-14 years) with behavior disorders. Using a multiple baseline across behaviors design to evaluate the effects, researchers instructed students to self-monitor for on-task behavior, accuracy of problems answered, and disruptive behavior. Interobserver agreement between the participants and an experimental observer averaged 95% (range 75-100%) for on-task behavior and 98% (range 83-100%) for disruptive behavior, while there were infrequent and easily resolved discrepancies for academic accuracy. All participants achieved substantial increases in performance under the self-monitoring conditions, demonstrating the effectiveness of a self-monitoring intervention in increasing academically related on-task behaviors and in decreasing disruptive behaviors.

In another study, Wood et al. (1998) used a self-monitoring procedure to increase the on-task behavior of four at-risk middle school students and evaluated the indirect effects on academic performance. On task behavior consisted of (a) being in one’s seat at
the appropriate time; (b) using materials appropriately; (c) working on the assigned task; (d) following teacher directions; and (e) accepting teacher feedback appropriately.

Academic performance varied by task and involved the students completing an assignment. When a self-monitoring condition was implemented, on-task behavior increased significantly for all participants. Although academic performance increased slightly for all participants, increases occurred at a slower rate and did not achieve statistical significance for all participants. Experimental observers conducted observations of the self-monitoring participants to assess the accuracy of participant observations. The independent observer agreed with the student on 98% of the occasions (range: 80% to 100%). Experimental interobserver agreement ranged from 80% to 100% with a mean of 95%. Wood et al. showed that participants of self-monitoring interventions could both (a) increase levels of performance by observing their own behavior and (b) make accurate assessments of their own behavior. However, Wood et al. provide no theoretical explanations for the change in performance.

One factor that may influence the power of monitoring as a behavior change intervention is the accuracy of observations. In both of the self-monitoring studies reviewed above, researchers measured accuracy (through agreement) but did not comment on the potential effects that accuracy could have on self-monitoring. Alternatively, Hayes and Nelson (1983) argued that the effort to produce accurate self-monitoring may increase the effectiveness of the behavioral cues in the procedure. In order to examine self-monitoring more closely, Hayes and Nelson examined the behavior of face touching in college-aged females. Face touching was selected as a dependent variable because it is one of the few discrete public behaviors that occurs at a high rate in a normal population. Participants were divided into four groups: (a) a control group; (b) a
group in which participants self-monitored their own face touching behavior; (c) a group that was shown a slide saying “please don’t touch your face” each time participants engaged in face touching; and, (d) a group that was shown the same slide at fixed intervals, regardless of any face touching behavior. Whereas the control group experienced an average reduction of .2 face touches per subject, the self-monitoring, contingent cuing, and noncontingent cuing groups experienced an average reduction of 7.0, 5.6, and 6.5 face-touches, respectively. The findings suggest that self-monitoring produces behavior change effects similar to those of external cuing.

Hayes and Nelson (1983) suggested that all of the components of the self-monitoring procedure (instructions, recording devices, self-monitoring behaviors, etc.), rather than the sole component of monitoring, combine to produce the therapeutic effects. The researchers argued that attempting to attain greater accuracy when self-monitoring might simply increase the salience of those cues and enhance the effectiveness of the self-monitoring procedure, although effects can still be achieved with inaccurate self-monitors. If participants do not conduct accurate self-observations, an effect is still expected due to exposure of self-monitoring participants to the other relevant self-monitoring cues (e.g., the instructional set, recording equipment, the monitoring behavior itself). An experimenter who conducts observations of behavior is exposed to the same set of cues as one who self-monitors, except that one who observes the behavior of others is not exposed to the behavioral feedback that is a normal part of self-monitoring techniques. In short, the research appears to support the expectation that conducting observations should produce effects similar to self-monitoring, noting the difference in the lack of feedback received by those who conduct observations of another person.
Stated differently, based on the studies discussed above (Blake McCann & Sulzer-Azaroff, 1996; Hayes & Nelson, 1983; Lam et al., 1994; Wood et al., 1998), one might reasonably conclude that the procedure of conducting behavioral observations or evaluations will have an effect on the behavior of the observer, regardless of the ostensible focus of the participant’s observations (i.e., self or others). It can further be reasoned that the more specific and salient the cues (i.e., as is the potential result of increased observer accuracy), the larger the expected effects (Hayes & Nelson, 1983).

Performance Feedback

Feedback is one of the interventions most frequently used to improve human performance. Performance feedback has been used to improve the number of legal body checks delivered by a university hockey team (Anderson, Crowell, Doman, & Howard, 1988), improve the accuracy of banquet setups (LaFleur & Hyten, 1995), and to improve the safe driving performance of bus operators (Olson & Austin, 2001). Although the use of feedback has not always produced consistent effects, it has often achieved significant improvements on dependent measures (Alvero, Bucklin, & Austin, 2001).

Alvero, Bucklin, and Austin (2001) conducted a review of feedback usage across four different journals between 1985 and 1998. The authors evaluated all applied (field) studies on certain feedback characteristics (e.g., source, frequency, and medium) in combination with other events (e.g., antecedents, goal setting, and consequences) to determine the results generated by particular combinations of dependent variable values. This approach was also used in a review conducted by Balcazar, Hopkins, and Suarez (1985). Incorporating these additional dependent variables is critical, as feedback rarely occurs in the absence of other behavioral or non-behavioral interventions aimed at improving performance. To ignore these combinations would be naïve and generate
misleading results. In summary, by using this approach Alvero, Bucklin, and Austin (2001) identified the combination of feedback and antecedents (e.g., staff training) as having the most consistent effects (100% effective) in comparison to some of the other combinations evaluated.

Summary

The research that has been conducted to date has shown that: a) behavior-based safety is an effective way of reducing workplace injuries and costs to employers; b) explanations on the efficacy of self-monitoring techniques suggest that the observing response (and perhaps also its accuracy), as it was utilized in the current study, is an important determinant of the success of the BBS techniques; c) the performance of observers can change as a function of observing for safe behavior in a laboratory environment; and, d) the combination of antecedents (such as training) and feedback were shown to be effective in achieving performance gains.

Given the frequency with which observers assess the behavior of others in the BBS process, there are obvious benefits to further exploring the effects of conducting observations for safety performance. If an increase in safety behavior could be achieved as a function of having employees conduct observations for safety related behaviors, the benefits of including all employees as observers in the BBS process would be clear. Although including front-line employees in conducting safety observations is a common feature of applied behavior-based safety implementations, the author was unable to find any published studies that demonstrate the effects of observing on the observer.

A primary purpose of this research was to expand upon the findings of Alvero and Austin (in press). The current study utilized methodology similar to Alvero and Austin to determine if the findings could be replicated in an applied work environment. It was
predicted that the safety of observers would increase as a function of their observations of
coworker safety. A secondary purpose of this research was to extend the findings of
Alvero and Austin (in press) to investigate the impact of the accuracy of observations on
the behavior change of the observer. Although Alvero and Austin demonstrated behavior
change on the part of the observer, they were not able to estimate the impact of the
accuracy of observations. The current study sought to provide insight into this question
by calculating reliability on 100 percent of participants’ observations. Deviations from
the experimental observers’ recordings were counted as incorrect responses with regards
to accuracy. A final expansion of the Alvero and Austin (in press) study was the
introduction of feedback as a dependent variable, and an exploration of the interaction
between feedback and conducting observations versus feedback in the absence of
conducting observations.
METHOD

Setting and Participants

The present study was conducted on-site in two departments (patient accounting and patient scheduling) of a large hospital in mid-sized midwestern city. The work environment was similar to most climate controlled office environments in which individual workstations are utilized. The study utilized 6 participants from one department and 5 participants from another department, for a total of 11 participants. All participants were female ranging in age from early 20's to late 50's. The participants had been working in their current position, or a similar position (i.e., one that required sitting, typing, and talking on the phone), for an average of 6.1 years (SD: 4.4 years; range: 1-15 years). Of the 11 participants, 8 had never received any form of ergonomics training, 2 had been provided with information on how to arrange items on their desk to prevent strain injuries, and 1 participant was taught hand stretches to reduce her tendonitis. The only prerequisite skill that was required to participate in this experiment was the ability to touch type fluently. All participants also indicated that they (a) intended on continuing their employment with the hospital for at least eight weeks, (b) would allow others to observe their behavior on the job, and (c) would observe the behavior of other co-workers if called upon to do so. The participants’ activities while at work consisted of answering inbound telephone calls or making outbound telephone calls to resolve patient accounting issues and to schedule appointments with patients. The participants from these two departments spent their entire workday sitting at a computer terminal performing their jobs, which placed them at risk for MSDs.
Independent Variables

The independent variables for the study were: a) information about correct ergonomic behavior, b) conducting observations of other participants, and c) numerical feedback on the percent safe of the target behaviors.

Information on Ergonomic Behavior

Information was provided to participants on the correct and incorrect topographies of ergonomic behaviors. Information was derived from the International Business Machines (IBM) website (IBM, 2001). A sheet explaining all of the correct behaviors was also given to each participant to keep. A sample of this sheet is attached as Appendix A.

Observation of Ergonomic Behavior

Observation of ergonomic behavior was introduced by training the observer participants to use the scoring instrument correctly (see Appendix B for a sample of the scoring instrument). Participant observers were trained to a criterion of 60% agreement with an experimental observer when scoring the behavior of a confederate who simulated the tasks of the job, and each participant was able to achieve this level of accuracy on her first attempt. This low level of accuracy (relative to the levels of accuracy considered acceptable for experimental data) was deemed acceptable in this case, as the primary independent variable of interest was the act of conducting observations and not necessarily the accuracy of the observations conducted. In addition, this study attempted to simulate a consultant-driven application, in which we suspect lower levels of agreement criteria would be deemed as acceptable. Training to a criterion of 60% accuracy also served as a measure of integrity of the independent variable as it showed
that the participants knew how to use the scoring form, were somewhat familiar with the
scoring procedure and apparatus, and could identify the target behaviors to a reasonable
degree.

At the beginning of each day each participant observer and an experimental
observer conducted a joint observation of a non-observer participant. Next, experimental
observers conducted observations of the behavior of those participant observers who had
just completed observations of non-observer participants. The observation of the
behavior of the participant observer occurred within the range of 10-20 minutes following
the observation conducted by the participant observer. In the afternoon the experimental
observers conducted another set of observations of the behavior of all the participants in
the study. Each participant observer observed the same non-observer participant each
time they conducted an observation. Participant observers conducted one 5-min
observation per day for approximately two to three weeks.

Feedback

In the feedback condition, each performer was given written feedback describing
her average percent safe for each ergonomic behavior. The feedback provided was based
on data collected by the primary experimental observer during the morning session. The
feedback form itself contained the behavioral definition of each dependent variable, and a
space to write in the participant's score on each dependent variable for the previous
session (see Appendix C for a sample feedback form). Each participant was told that she
could expect to receive feedback on a daily basis in between the morning and afternoon
data collection sessions, and that the feedback delivered would be based on the morning
session that she had previously completed, and that no feedback would be given on
afternoon sessions. Feedback forms were delivered to the participant within a range of 5-20 minutes before the beginning of the second observation session of the day.

**Integrity of the Independent Variables**

To assess the participants' knowledge of correct ergonomic behaviors a quiz was given which covered the material in Appendix A. The quiz was administered on the same day the information about correct ergonomic behaviors was delivered (see Appendix D for a sample of the Ergonomic Behaviors Quiz).

To assess the integrity of conducting observations for ergonomic behavior, and to calculate the accuracy of the participant observers' observations of behavior, interobserver agreement measures were collected for 100% of the occasions with the participant observers. Consistent reliability measures, as well as the presence of the experimenter during all observations ensured that participant observations were conducted as intended.

**Dependent Variables**

The behaviors selected as dependent variables have been established as being linked to MSDs resulting from extended periods of office work (NIOSH, 2000; USDOL, 1998). All variables were calculated as a percentage of safe intervals by dividing the number of safe intervals (indicated by a “+” on the behavior recording form) over the total number of applicable intervals (indicated by a “+” or “-” on the behavior recording form) for the observation session, and multiplying the resulting quotient by 100% (see Appendix B for a sample of the recording form). Using a momentary time sampling procedure, all dependent variables were marked as having occurred (“safe” or “not safe”) or not occurred (“not applicable”). Each dependent variable was then calculated as a
percent safe, as described above, using the occurrence data for the observation period. Experimental observers measured the dependent variables by standing in close proximity (within 2m) to the participant and observing and recording behavior. Experimental observers carried a tape recorder that, through an ear bud, cued observations every four seconds (providing one second to observe and three seconds to record the result). Each dependent variable was measured in a rotating fashion for each participant until 20 observations were conducted for each dependent variable and each participant. The entire observation procedure required approximately five minutes per participant. The operational definitions for the dependent variables selected for the study are listed below.

1. **Wrist Position**: When typing, the wrists should be in line with the elbows, not bent/extended upward or downward.

2. **Neck Position**: When sitting, the neck should be aligned with the back; eyes should be level with the screen and document.

3. **Back / Shoulder Position**: When sitting, the back should be upright, parallel to and up against the back of the chair (not leaning against it). Shoulders should be in line with the back and hips, not slouched forward or arched backward.

4. **Foot Position**: When sitting, both feet should be flat on the floor (ball of foot and heel should touch floor or foot rest if a foot rest is used).

Two secondary measures were also collected:

1. **Accuracy of Observations**: Accuracy of observations was calculated for all participant observations using the same formula as that described to calculate interobserver agreement for experimental observations. However, to represent the agreement measure as a measure of accuracy I deemed that the experimental
observer was 100% correct in their scoring and considered deviations by the participant observer to be instances of inaccurate recording.

2. Participant Exit Interview Responses- During the debriefing session conducted one-on-one between the experimenter and the participant, each participant was asked a series of questions as an exit interview. One final follow-up question was asked after four-month follow-up data were collected, however participants 1, 7, and 11 were not available to be asked the additional question. The list of questions asked and their corresponding answers are presented later in this paper.

Interobserver Agreement

Interobserver agreement was conducted with a primary data collector for all behaviors during 67% of the experimental observations (for agreement on experimental data), and with the participant observers on 100% of the occasions (for agreement as a measure of participant observation accuracy). Data collection was unobtrusive, but the experimenter's presence was apparent, just as it would be in a consultant-driven application of behavior-based safety. Interobserver agreement percentages were calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying the resulting quotient by 100%.

Procedures

Participant Recruitment and Informed Consent Process

The experimenter spoke with each person in the two departments on an individual basis. He read aloud the informed consent sheet (see Appendix E) to each employee and asked the employee if she had any questions regarding any dimension of the study, including its requirements, risks, and/or benefits. Next the experimenter summarized
exactly what the consent document said, retouched on the risks and benefits to the potential participants, and again prompted for any questions. The experimenter then asked the employee if she would like to participate in the study. If the employee chose to participate, then she was able to sign one copy of the informed consent form at that time, and was also given her own copy to keep. If the employee did not want to participate, the experimenter thanked her and moved on to the next person, and also left a copy of the consent form with the employee so that the volunteers were not distinguishable from the employees that did not volunteer. If the employee desired more time to think it over, the experimenter simply asked for a good time to check back with the person and then did so at the specified time. The experimenter also informed the participants that the second copy of the permission paperwork was to be retained by them in case they would like to refer back to it at a later time during the course of the study. It was also explained to the volunteer that the return of one signed copy of the permission paperwork would qualify the participant to be included in the study, but it would not guarantee inclusion in the study. Once everyone had a chance to respond, the experimenter chose 11 of the 11 signed consent forms and informed the participants that they were chosen to participate in the study. The goals of this consent process were to fully inform potential participants of the details involved in the study, and to make supervisors and coworkers unaware of who had volunteered and who had not volunteered to avoid any confrontation in the workplace.

**Phase One: Baseline**

Phase one was a baseline phase. Experimental observers observed the eleven participants working individually and collected data without disrupting the participants'
work in any way. Data were collected using the behavior recording form (see Appendix B) on two occasions per day throughout the study.

**Phase Two: Information and Training**

Phase two began with a brief training session on ergonomic behavior. Each training session was conducted as a one-on-one meeting between the experimenter and each participant and each session lasted approximately ten minutes. During the training, information on the correct and incorrect topographies of the ergonomic target behaviors was provided to all participants. A sheet explaining all of the “correct” (i.e., safe) behaviors was given to each participant to keep. A sample of this sheet is attached as Appendix A. After the information on ergonomic behavior was distributed, the participants completed a brief quiz over the material. Quiz scores were to be used as a general reference of the amount of information a participant had learned from the material (i.e., independent variable integrity). If a participant answered four or more questions (out of eight) incorrectly she would have been asked to complete the quiz again the next day, if the participant achieved a score of five or greater correct she would not have been asked to complete the quiz again. All participants “passed” the quiz on their first attempt and no participants were asked to repeat the quiz. Results of the quiz indicated that all of the participants could identify and define the target behaviors, as all participants scored 100% correct (i.e., 8 answers of 8 questions were correct). A sample of the quiz used in the study is attached as Appendix D. After the quiz had been completed, the experimenter modeled correct ergonomic positions for the participant, and also had the participant model each behavior one time to ensure they could perform it correctly, as well as define it correctly. All participants were able to model the target behaviors correctly during the training session. Throughout this phase the experimental observers
continued to collect data on the target behaviors using the same procedures described in phase one.

**Phase Three: Conducting Observations**

In phase three of the study, the two groups (n=6, n=5) were randomly divided in half, into observers (n=3 for each group) and non-observers (n=3, n=2, respectively). Within each group, observers were randomly paired with non-observers to determine exactly whose behavior would be observed by each participant observer. During each day of phase three, the experimental observers and each participant observer (one at a time) jointly collected data on the behavior of the non-observer participant with whom that participant observer was paired. Next, the experimental data collector conducted an observation of the participants in the observer group. Each participant in the observer group observed the same non-observer each time they conducted an observation during this phase. Participant observers conducted one observation per day for approximately two to three weeks.

Approximately three hours after the joint observation conducted by an experimental observer and each participant in the observer group, the experimental observers alone conducted another set of observations on the behavior of all of the participants in the study. Throughout the study, before any participant was observed, she was asked, “Is it okay if I (we) conduct an observation at this time?” If the participant indicated that it was a good time for an observation to occur then one was conducted at that time. If the participant indicated that it was not a good time for an observation to occur then the experimenter asked for a potentially better time and returned at the given time to try again. Throughout the course of the study, being asked to return at a better time was a very infrequent event. By approaching all observations in this manner the
participants knew each time that they were being observed, and did not feel pressured to remain seated throughout an observation session in which they may have otherwise gotten up from their seat for any number of reasons.

Phase Four: Individual Written Feedback

Phase four utilized the same experimental procedures as phase three, with the addition of individual written (numerical) feedback. Participants that conducted observations in phase three continued to do so in phase four (with the exception of participant 10). Likewise, participants that did not conduct observations in phase three did not conduct observations in phase four.

At the onset of phase four the experimenter met with each participant individually and explained that the participant would now be given information on how well they were performing. The participant was shown the form used to deliver feedback, and was told that she could expect to receive feedback on a daily basis in between the morning and afternoon data collection sessions. At this time participants were also informed that the feedback delivered would be based on the morning session which they had previously completed, and that no feedback would be given on afternoon sessions. Each day the experimental investigator handed a completed feedback form to each participant, or left the form face down on her keyboard if she was not at her desk (see Appendix C for a sample feedback form). Feedback forms were delivered to the participant within a range of 5-20 minutes before the beginning of the second observation session of the day.

Phase Five: Follow-up Data Collection

Approximately four months following the completion of the feedback phase, experimental observers returned to the setting to collect follow-up data. Participants did
not conduct observations, nor did any participants receive feedback. Experimental observers collected data on the target behaviors using the same procedures described in phase one.

**Research Assistant Training and Reliability**

Before data collection began, research assistants were brought together for a series of training meetings. During the first meeting the experimenter explained the BBS process and the benefits of BBS. He then reviewed the study and what the roles of the research assistants were to be. At this meeting the research assistants had an opportunity to ask questions and gain a full understanding of what the study involved. Research assistants were informed of the phases of the study, and by necessity they were aware of the onset of the observation and feedback conditions, but they were not made aware of the onset of the information condition, which was fully implemented by the experimenter. Research assistants were also told to become fluent with all of the dependent variables by the second meeting. During the second meeting the research assistants were given a quiz on the dependent variables. All assistants scored 100% correct (the quiz can be seen in Appendix D). If the research assistants did not score 100% correct on the quiz they would have been required to repeat the quiz at successive meetings until a score of 100% was achieved. The second meeting was also used to train the research assistants in the use of the behavior recording form (see Appendix B). At this meeting assistants began to practice recording data with the data recording form, using the experimental procedure and human volunteers who worked at a workstation in order to provide a realistic simulation of observing a real person engaging in work tasks. The third and successive meetings were used to train the data collectors to achieve reliability with their observations. Using the primary experimenter’s data as a benchmark, data collectors
were trained to a criterion of 90% reliability for all behaviors for two consecutive scorings. Reliability of observations for each behavior was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying the resulting quotient by 100%.

Experimental Design

The current study employed a within subject, multiple-baseline across groups design. Eleven participants were divided into two groups (n=6, n=5) based on the department in which they were employed. Exposure to the independent variables was staggered by providing information to two participants of the first group, then information to the other four members of the first group, and then finally information to all five members of the second group. Successive applications of independent variables were introduced by first exposing the first group in its entirety and then the second group in its entirety. At the beginning of the third condition (conducting observations), each of the two groups of was further subdivided into two groups. The first group was subdivided so that three of the participants served as observers and three did not, whereas the second group was subdivided so that three of the participants served as observers and two did not. During the feedback condition all participants who were serving as observers continued to serve as observers, and those who were not serving as observers continued to participate as non-observers, with the exception of participant 10. At the end of the third condition participant 11 drastically reduced her hours and so participant 10 ceased conducting observations to maintain an equal number of observers and non-observers. Approximately four months following the completion of the feedback phase, experimental observers returned to the setting to collect follow-up data. The follow-up phase was similar to a return to baseline, as participants did not conduct observations or
receive feedback, and experimental observers collected data on the target behaviors using the same procedures described in the baseline condition.

Debriefing Process

Participants were debriefed at the end of the study once all of the data had been collected. The student investigator met with each participant individually at her workstation and went through the debriefing script (attached as Appendix F). Debriefing sessions lasted approximately 30 minutes and included: asking the participant some brief questions regarding participation in the study and about any previous exposure they may have had to ergonomics training (the questions asked are attached as Appendix G); thanking the participant for participating the research study; explaining the purpose of the study; showing the participant graphs of her performance and asking her if she had any questions about her performance; explaining how her performance relates to the research question, and asking the participant if she had any questions regarding participation in the project and answering her questions.
RESULTS

General Interpretation

The results of this study are presented below in terms of the means, standard deviations, and ranges of the data obtained in each phase. As no noticeable differences emerged between morning and afternoon sessions (except where noted in the discussion section), data for morning and afternoon sessions were averaged to achieve a single score for each behavior on each day. Therefore, the data presented below represent an average of the morning and afternoon scores for each day in each phase. For example, if the morning session for neck performance yielded a score of 30% safe and the afternoon session yielded a score of 60% safe, the score used for calculations pertaining to that day would be 45% safe for neck performance, assuming there were equal number of applicable intervals in each session. As many morning and afternoon sessions had a different number of applicable intervals (i.e., a person may have been typing during fewer intervals), the averages represented are weighted averages. Overall scores, which represent a daily average of overall safety performance, were calculated by dividing the number of safe intervals (across all behaviors) by the sum of the number of safe and unsafe intervals (across all behaviors). To remain consistent with daily averaged measures, ranges are also presented as a daily average of morning and afternoon scores instead of scores by observation session.

Participant 1

Figure 1 depicts the safety performance of participant 1 throughout all phases of the study. Neck position averaged 85% safe during baseline (SD: 9.9; range: 65% -
Figure 1. Data for Participant 1. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored.

100%) and increased to 90% safe during the information phase (SD: 12.5; range: 48% - 100%). During the feedback condition performance rose to 99% safe (SD: 3.6; range: 88% - 100%) and remained at 99% safe during the follow-up condition (SD: 1.2; range: 98% - 100%). Performance on back and shoulder position averaged 24% safe during
baseline (SD: 26.6; range: 0% - 88%) and decreased to 18% safe during the information phase (SD: 15.5; range: 0% - 50%). During the feedback condition performance climbed to 52% safe (SD: 28.7; range: 0% - 88%) and was assessed at 98% safe during the follow-up condition (SD: 2.9; range: 95% - 100%). Wrist position averaged 97% safe during baseline (SD: 12; range: 55% - 100%) and increased to 100% safe during the information phase. Wrist position remained at 100% throughout the remaining phases of the study. Foot position averaged 53% safe during baseline (SD: 34.3; range: 0% - 96%) and improved to 88% safe during the information phase (SD: 18.5; range: 45% - 100%). During the feedback condition performance rose to 97% safe (SD: 6.6; range: 78% - 100%) and was assessed at 100% safe during the follow-up condition. Overall safe performance averaged 57% safe during baseline (SD: 15.1; range: 28% - 83%) and climbed to 68% safe during the information phase (SD: 8.4; range: 52% - 84%). During the feedback condition performance rose to 84% safe (SD: 9.4; range: 71% - 96%) and was assessed at 99% safe during the follow-up condition (SD: 1.0; range: 98% - 100%).

Participant 2

Figure 2 depicts the safety performance of participant 2 throughout all phases of the study. Neck position averaged 89% safe during baseline (SD: 11.2; range: 68% - 100%) and increased to 92% safe during the information phase (SD: 9.4; range: 75% - 100%). During the observation condition performance improved to 99% safe (SD: 2.3; range: 95% - 100%), fell to 98% safe (SD: 3; range: 90% - 100%) in the feedback condition, and was assessed at 100% safe during the follow-up condition. Back and shoulder performance averaged 39% safe during baseline (SD: 41.5; range: 0% - 100%) and decreased to 1% safe during the information phase (SD: 2.8; range: 0% - 10%). During the observation condition performance rose to 6% safe (SD: 10.5; range: 0% -
Figure 2. Data for Participant 2. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored. 25%), increased to 35% safe (SD: 29.3; range: 0% - 95%) in the feedback condition, and was assessed at 100% safe during the follow-up condition. Wrist position averaged 97% safe during baseline (SD: 10.4; range: 67% - 100%) and decreased to 93% safe during the
information phase (SD: 13.9; range: 63% - 100%). During the observation condition performance climbed to 99% safe (SD: 1.9; range: 95% - 100%). In the feedback condition performance rose to 100% safe and remained at that level during follow-up. Foot position averaged 6% safe during baseline (SD: 15.8; range: 0% - 50%) and decreased to 5% safe during the information phase (SD: 14.0; range: 0% - 50%). During the observation condition performance fell to 4% safe (SD: 9.9; range: 0% - 28%), improved to 76% safe (SD: 30.3; range: 0% - 100%) in the feedback condition and was assessed at 85% safe during the follow-up condition (SD: 26.4; range: 45% - 100%). Overall safe performance averaged 51% safe during baseline (SD: 12.1; range: 36% - 69%) and decreased to 39% safe during the information phase (SD: 6.4; range: 27% - 51%). During the observation condition performance rose to 42% safe (SD: 7.3; range: 33% - 56%), increased to 73% safe (SD: 14.1; range: 42% - 97%) in the feedback condition and was assessed at 95% safe during the follow-up condition (SD: 7.5; range: 84% - 100%).

Participant 3

Figure 3 depicts the safety performance of participant 3 throughout all phases of the study. Neck position averaged 94% safe during baseline (SD: 6.9; range: 80% - 100%) and increased to 99% safe during the information phase (SD: 2; range: 95% - 100%). During the feedback condition performance rose to 100% safe (SD: 0.9; range: 98% - 100%) and was assessed at 100% safe during the follow-up condition. Performance on back and shoulder position averaged 38% safe during baseline (SD: 35.5; range: 0% - 90%) and decreased to 22% safe during the information phase (SD: 28.4; range: 0% - 100%). During the feedback condition performance rose to 62% safe (SD: 27; range: 20% - 100%) and was assessed at 100% safe during the follow-up condition.
Figure 3. Data for Participant 3. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored.

Wrist position averaged 97% safe during baseline (SD: 6.2; range: 81% - 100%) and increased slightly to 98% safe during the information phase (SD: 5.2; range: 82% -
Wrist position remained at 100% throughout the remaining phases of the study. Foot position averaged 15% safe during baseline (SD: 21; range: 0% - 50%) and rose to 17% safe during the information phase (SD: 23.2; range: 0% - 53%). During the feedback condition performance improved to 67% safe (SD: 35.6; range: 0% - 100%) and was assessed at 65% safe during the follow-up condition (SD: 26; range: 50% - 95%). Overall safe performance averaged 59% safe during baseline (SD: 11.4; range: 46% - 77%) and decreased slightly to 56% safe during the information phase (SD: 11.2; range: 43% - 74%). During the feedback condition performance rose to 81% safe (SD: 13.4; range: 62% - 100%) and was assessed at 91% safe during the follow-up condition (SD: 6.9; range: 87% - 99%).

Participant 4

Figure 4 depicts the safety performance of participant 4 throughout all phases of the study. Neck position averaged 92% safe during baseline (SD: 8.4; range: 73% - 100%) and increased to 98% safe during the information phase (SD: 3.2; range: 90% - 100%). During the feedback condition performance decreased slightly to 97% safe (SD: 6; range: 80% - 100%) and was assessed at 100% safe during the follow-up condition. Performance on back and shoulder position averaged 15% safe during baseline (SD: 27.7; range: 0% - 100%) and decreased to 5% safe during the information phase (SD: 9.4; range: 0% - 28%). During the feedback condition performance rose to 17% safe (SD: 23.8; range: 0% - 65%) and was assessed at 60% safe during the follow-up condition (SD: 21.6; range: 40% - 90%). Wrist position averaged 87% safe during baseline (SD: 29.2; range: 0% - 100%) and increased to 96% safe during the information phase (SD: 10.8; range: 60% - 100%). During the feedback phase wrist position remained at 96% safe (SD: 14.2; range: 55% - 100%) and was assessed at 100% during the follow-up
Figure 4. Data for Participant 4. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored.

condition. Foot position averaged 45% safe during baseline (SD: 48.2; range: 0% - 100%) and increased to 67% safe during the information phase (SD: 39.1; range: 0% - 100%). During the feedback condition performance rose to 88% safe (SD: 16.3; range: 
46% - 100%) and was assessed at 99% safe during the follow-up condition (SD: 1.5; range: 97% - 100%). Overall safe performance averaged 57% safe during baseline (SD: 9.1; range: 42% - 71%) and increased to 60% safe during the information phase (SD: 12.6; range: 36% - 76%). During the feedback condition performance rose to 67% safe (SD: 8.1; range: 54% - 81%) and was assessed at 86% safe during the follow-up condition (SD: 7.6; range: 79% - 97%).

Participant 5

Figure 5 depicts the safety performance of participant 5 throughout all phases of the study. Neck position averaged 99% safe during baseline (SD: 2.1; range: 93% - 100%) and decreased to 97% safe during the information phase (SD: 2.8; range: 93% - 100%). During the observation condition performance fell to 95% safe (SD: 8.9; range: 75% - 100%), rose to 99% safe (SD: 2; range: 93% - 100%) in the feedback condition, and was assessed at 100% safe during the follow-up condition (SD: 1; range: 98% - 100%). Back and shoulder performance averaged 20% safe during baseline (SD: 30.5; range: 0% - 93%) and decreased to 4% safe during the information phase (SD: 6; range: 0% - 15%). During the observation condition performance rose to 15% safe (SD: 30.5; range: 0% - 88%), improved again to 34% safe (SD: 31.3; range: 0% - 93%) in the feedback condition, and was assessed at 99% safe during the follow-up condition (SD: 2.5; range: 95% - 100%). Wrist position averaged 92% safe during baseline (SD: 11.7; range: 65% - 100%) and increased to 98% safe during the information phase (SD: 4; range: 89% - 100%). Performance climbed to 100% safe during the observation condition and remained at 100% safe throughout the rest of the study and follow-up. Foot position averaged 74% safe during baseline (SD: 23.2; range: 18% - 100%) and increased to 92% safe during the information phase (SD: 9.5; range: 78% - 100%). During the
observation condition performance maintained at 92% safe (SD: 9.3; range: 73% -
100%), rose to 97% safe (SD: 6.4; range: 80% - 100%) in the feedback condition, and
was assessed at 59% safe during the follow-up condition (SD: 46.2; range: 0% - 98%).
Overall safe performance averaged 67% safe during baseline (SD: 6; range: 55% - 79%)
and increased to 68% safe during the information phase (SD: 5.1; range: 61% - 76%). During the observation condition performance rose to 69% safe (SD: 11.6; range: 58% - 94%), increased again to 78% safe (SD: 10.2; range: 68% - 98%) in the feedback condition and was assessed at 87% safe during the follow-up condition (SD: 13.4; range: 70% - 98%).

Participant 6

Figure 6 depicts the safety performance of participant 6 throughout all phases of the study. Neck position averaged 88% safe during baseline (SD: 11.6; range: 60% - 100%) and increased to 97% safe during the information phase (SD: 4.3; range: 88% - 100%). During the observation condition performance fell to 94% safe (SD: 4.7; range: 88% - 100%), rose to 99% safe (SD: 3.5; range: 90% - 100%) in the feedback condition, and was assessed at 99% safe during the follow-up condition (SD: 1.2; range: 98% - 100%). Back and shoulder performance averaged 16% safe during baseline (SD: 26.8; range: 0% - 73%) and decreased to 2% safe during the information phase (SD: 4; range: 0% - 13%). During the observation condition performance rose to 10% safe (SD: 15.9; range: 0% - 48%), increased to 54% safe (SD: 41.1; range: 0% - 100%) in the feedback condition, and was assessed at 96% safe during the follow-up condition (SD: 7.5; range: 85% - 100%). Wrist position averaged 98% safe during baseline (SD: 4.6; range: 86% - 100%) and increased to 99% safe during the information phase (SD: 2.6; range: 92% - 100%). Performance was assessed at 100% safe during the observation condition and remained at 100% safe throughout the remaining conditions and follow-up. Foot position averaged 27% safe during baseline (SD: 20.5; range: 0% - 50%) and increased to 89% safe during the information phase (SD: 12.1; range: 65% - 100%). During the observation condition performance fell to 84% safe (SD: 17.5; range: 55% - 100%), rose
Figure 6. Data for Participant 6. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored. To 97% safe (SD: 7; range: 80% - 100%) in the feedback condition and was assessed at 99% safe during the follow-up condition (SD: 1.2; range: 98% - 100%). Overall safe performance averaged 57% safe during baseline (SD: 7.4; range: 43% - 68%) and
increased to 68% safe during the information phase (SD: 5.2; range: 59% - 75%). During the observation condition performance remained at 68% safe (SD: 9.8; range: 55% - 85%), increased to 85% safe (SD: 12.6; range: 71% - 100%) in the feedback condition, and was assessed at 98% safe during the follow-up condition (SD: 1.7; range: 96% - 100%).

Participant 7

Figure 7 depicts the safety performance of participant 7 throughout all phases of the study. Neck position averaged 95% safe during baseline (SD: 9.1; range: 67% - 100%) and increased to 97% safe during the information phase (SD: 4.5; range: 85% - 100%). Performance climbed to 100% safe during the feedback condition (SD: 0.7; range: 98% - 100%). Performance on back and shoulder position averaged 28% safe during baseline (SD: 33.9; range: 0% - 100%) and increased to 42% safe during the information phase (SD: 29.5; range: 0% - 100%). During the feedback condition performance rose to 71% safe (SD: 29.9; range: 8% - 98%). Wrist position averaged 83% safe during baseline (SD: 31.2; range: 17% - 100%) and increased to 97% safe during the information phase (SD: 11.2; range: 50% - 100%). During the feedback phase, wrist position climbed to 100% safe. Foot position averaged 69% safe during baseline (SD: 26.5; range: 16% - 100%) and increased to 92% safe during the information phase (SD: 13.4; range: 53% - 100%). Performance rose to 99% safe (SD: 1.1; range: 97% - 100%) during the feedback condition. Overall safe performance averaged 66% safe during baseline (SD: 15.6; range: 39% - 99%) and increased to 79% safe during the information phase (SD: 10.3; range: 56% - 100%). During the feedback condition performance rose to 91% safe (SD: 8.2; range: 74% - 99%).
Figure 7. Data for Participant 7. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored.
Participant 8

Figure 8 depicts the safety performance of participant 8 throughout all phases of the study. Neck position averaged 96% safe during baseline (SD: 4.9; range: 85% - 100%) and increased slightly to 97% safe during the information phase (SD: 4; range: 90% - 100%). During the observation condition performance rose to 100% safe (SD: 0.6; range: 98% - 100%), decreased slightly to 99% safe (SD: 2.7; range: 93% - 100%) in the feedback condition, and returned to 100% safe during the follow-up condition. Back and shoulder performance averaged 10% safe during baseline (SD: 23.2; range: 0% - 85%) and decreased to 1% safe during the information phase (SD: 1.7; range: 0% - 5%). During the observation condition performance rose to 33% safe (SD: 38.6; range: 0% - 100%), increased again to 50% safe (SD: 46.1; range: 0% - 95%) in the feedback condition, and was assessed at 34% safe during the follow-up condition (SD: 26; range: 0% - 58%). Wrist position averaged 84% safe during baseline (SD: 27.9; range: 10% - 100%) and improved to 90% safe during the information phase (SD: 30; range: 10% - 100%). Performance rose to 100% during the observation condition and fell slightly to 98% safe in the feedback condition (SD: 4.2; range: 89% - 100%). Performance returned to 100% safe during the follow-up condition. Foot position averaged 6% safe during baseline (SD: 13.4; range: 0% - 50%) and increased to 34% safe during the information phase (SD: 41.9; range: 0% - 100%). During the observation condition performance rose to 95% safe (SD: 7.8; range: 78% - 100%), fell to 94% safe (SD: 8.4; range: 78% - 100%) in the feedback condition, and fell again to 88% safe during the follow-up condition (SD: 13.9; range: 73% - 100%). Overall safe performance averaged 45% safe during baseline (SD: 10.9; range: 30% - 65%) and increased to 51% safe during the information phase (SD: 10.4; range: 40% - 73%). During the observation condition performance rose to
Figure 8. Data for Participant 8. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored.

80% safe (SD: 10.8; range: 69% - 100%), increased again to 85% safe (SD: 10.3 range: 74% - 99%) in the feedback condition, and was assessed at 76% safe during the follow-up condition (SD: 10; range: 64% - 88%).
Participant 9

Figure 9 depicts the safety performance of participant 9 throughout all phases of the study. Neck position averaged 97% safe during baseline (SD: 4.7; range: 86% - 100%) and decreased to 94% safe during the information phase (SD: 7.6; range: 78% - 100%). During the observation condition performance rose to 99% safe (SD: 1.7; range: 95% - 100%), climbed to 100% safe in the feedback condition, and was assessed at 99% safe during the follow-up condition (SD: 2.5; range: 95% - 100%). Back and shoulder performance averaged 20% safe during baseline (SD: 21.8; range: 0% - 63%) and decreased to 13% safe during the information phase (SD: 12.4; range: 0% - 30%). During the observation condition performance rose to 48% safe (SD: 32.8; range: 5% - 93%), increased to 78% safe (SD: 19.7; range: 43% - 93%) in the feedback condition, and was assessed at 87% safe during the follow-up condition (SD: 26; range: 48% - 100%). Wrist position averaged 92% safe during baseline (SD: 23.9; range: 0% - 100%) and increased to 99% safe during the information phase (SD: 1.7; range: 95% - 100%). Performance rose to, and maintained at, 100% safe throughout the observation, feedback, and follow-up conditions. Foot position averaged 5% safe during baseline (SD: 10.4; range: 0% - 43%) and increased to 26% safe during the information phase (SD: 20; range: 0% - 88%). During the observation condition performance rose to 82% safe (SD: 14.3; range: 53% - 95%), improved again to 94% safe (SD: 6.1; range: 83% - 100%) in the feedback condition, and was assessed at 83% safe during the follow-up condition (SD: 33.2; range: 33% - 100%). Overall safe performance averaged 48% safe during baseline (SD: 6.9; range: 39% - 64%) and increased to 51% safe during the information phase (SD: 10.2; range: 35% - 67%). During the observation condition performance rose to 79% safe (SD: 12.1; range: 57% - 94%), increased again to 92% safe (SD: 6.1; range:
Figure 9. Data for Participant 9. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored. 82% - 98%) in the feedback condition, and was assessed at 91% safe during the follow-up condition (SD: 17.7; range: 64% - 100%).
Participant 10

Figure 10 depicts the safety performance of participant 10 throughout all phases of the study. Neck position averaged 80% safe during baseline (SD: 15.7; range: 47% - 100%) and increased to 95% safe during the information phase (SD: 5.1 range: 85% - 100%). During the observation condition performance maintained at 95% safe (SD: 5.3; range: 85% - 100%), rose to 99% safe in the feedback condition (SD: 2.1; range: 93% - 100%), and was assessed at 100% safe during the follow-up condition. Back and shoulder performance averaged 8% safe during baseline (SD: 15.8; range: 0% - 58%) and decreased to 1% safe during the information phase (SD: 2.5; range: 0% - 8%). During the observation condition performance maintained at 1% safe (SD: 1.9; range: 0% - 5%), increased to 20% safe (SD: 19.1; range: 0% - 50%) in the feedback condition, and was assessed at 83% safe during the follow-up condition (SD: 19.4; range: 65% - 100%). Wrist position averaged 94% safe during baseline (SD: 22.9; range: 0% - 100%) and increased to 98% safe during the information phase (SD: 6.6; range: 79% - 100%). Performance returned to 94% safe during the observation condition (SD: 11.1; range: 71% - 100%), rose to 100% safe in the feedback condition, and maintained at 100% safe during the follow-up condition. Foot position averaged 5% safe during baseline (SD: 11.4; range: 0% - 47%) and increased to 17% safe during the information phase (SD: 17.5; range: 0% - 50%). During the observation condition performance rose to 66% safe (SD: 28.9; range: 18% - 95%), improved again to 70% safe (SD: 22.2; range: 23% - 95%) in the feedback condition, and was assessed at 64% safe during the follow-up condition (SD: 25.4; range: 28% - 85%). Overall safe performance averaged 35% safe during baseline (SD: 6.9; range: 22% - 47%) and increased to 43% safe during the information phase (SD: 5.2; range: 36% - 54%). During the observation condition performance
Figure 10. Data for Participant 10. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored.

improved to 57% safe (SD: 9.6; range: 42% - 69%), increased again to 66% safe (SD: 10; range: 49% - 80%) in the feedback condition, and was assessed at 83% safe during the follow-up condition (SD: 11.4; range: 67% - 93%).


Participant 11

Figure 11 depicts the safety performance of participant 11 throughout all phases of the study. Neck position averaged 96% safe during baseline (SD: 7.7; range: 75% - 100%) and increased to 98% safe during the information phase (SD: 4; range: 85% - 100%). Performance maintained at 99% safe during the feedback condition (SD: 1.2; range: 98% - 100%). Performance on back and shoulder position averaged 41% safe during baseline (SD: 39.9; range: 0% - 100%) and decreased to 37% safe during the information phase (SD: 22.3; range: 0% - 71%). During the feedback condition performance rose to 46% safe (SD: 25.9; range: 28% - 76%). Wrist position averaged 95% safe during baseline (SD: 11.6; range: 67% - 100%) and increased to 98% safe during the information phase (SD: 4.2; range: 85% - 100%). During the feedback phase, wrist position increased to 100% safe. Foot position averaged 29% safe during baseline (SD: 41.5; range: 0% - 100%) and increased to 87% safe during the information phase (SD: 15; range: 50% - 100%). During the feedback condition performance rose to 98% safe (SD: 2.9; range: 95% - 100%). Overall safe performance averaged 58% safe during baseline (SD: 15.2; range: 39% - 89%) and increased to 75% safe during the information phase (SD: 8.3; range: 65% - 91%). During the feedback condition performance rose to 84% safe (SD: 7.6; range: 77% - 92%).
Figure 11. Data for Participant 11. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored.
Overall Safety

Overall measures of safety are comprised of a weighted average of safe performance across all target behaviors. The average scores by phase, along with their standard deviations and ranges are presented along with each participant’s results above. Figure 12 displays the overall percent safe scores of each non-observer participant across all phases, and Figure 13 displays the overall percent safe scores of each observer participant across all phases.
Overall Percent Safe

Figure 12. Overall Percent Safe Scores for Non-Observer Participants. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored, Averaged Across All Behaviors for the Non-Observer Participants.
Figure 13. Overall Percent Safe Scores for Participant Observers. The Figure Represents the Number of Intervals in Which Safe Behavior Was Observed as a Percentage of the Intervals Scored, Averaged Across All Behaviors for the Participant Observers.
Accuracy of Observations

Overall participant accuracy was correlated with overall percent safe scores. Correlations were calculated between the average percent safe score by day (a weighted average of both morning and afternoon sessions) and the accuracy score obtained on the observation conducted during the same day. The correlations are comprised only of days in the observation phase during which the participant observer was not receiving feedback. The Pearson correlation coefficient \( r \) between percent safe and accuracy was \( r = -.09 \) for participant 2; \( r = .44 \) for participant 5; \( r = .07 \) for participant 6; \( r = .06 \) for participant 8; \( r = .70 \) for participant 9; and \( r = .92 \) for participant 10. Scatterplots of these correlations are shown below for participants 2, 5, 6, 8, 9, and 10 (see Figures 14, 15, 16, 17, 18, and 19 respectively).

![Participant 2- Scatterplot](image)

Figure 14. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 2.
Figure 15. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 5.

Figure 16. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 6.
Figure 17. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 8.

Figure 18. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 9.
Figure 19. The Relationship Between Observer Accuracy and Percent Safe Scores for Participant 10.

Participant Exit Interview Responses

During the debriefing session conducted one-on-one between the experimenter and each participant, the experimenter asked each participant a series of questions as an exit interview. Each participant was also asked one final question after four-month follow-up data were collected, however participants 1, 7, and 11 were not available during the follow-up condition to be asked the additional question. Below is a list of questions asked of each participant at the end of the study and a summary of participant answers. Each question listed is followed by the answers given by each participant. As multiple participants often had the same answer, the number of the participant(s) who responded with each answer is reported. Some questions asked were only relevant to participants who conducted observations, so non-observer participants were not required to answer all of the questions presented. Each set of answers is represented with the letter “A” and the numbers “1” through “8” corresponding to the answer number.
Q1 (Question #1): What did you think was being measured before you received the information on ergonomics? (Answer #1) given by participants 1, 2, 3, 5, 7, 10, 11: ergonomics, (A2) participant 4: never thought about it, (A3) participants 6, 8: wasn’t sure, (A4) participant 9: posture.

Q2: Did you find yourself thinking about safety when you were being observed? (A1) participants 1-11: yes.

Q3: Did you find yourself thinking about safety when you were not being observed? (A1) participants 1, 2, 3, 4, 5, 6, 7, 8, 10, 11: occasionally, (A2) participant 9: yes.

Q4: What did you think the purpose of conducting observations was? (A1) participant 2: to gain insight on how someone else performs, (A2) participant 5: to see if what the experimenters think is safe varies from what the participant thinks is safe, (A3) participant 6: to make me more aware of the correct positions, (A4) participants 8, 9: so I could see for myself what is and is not correct, (A5) participant 10: to eventually look at how people perform using different types of equipment.

Q5: Do you think your behavior changed throughout the course of the study? (A1) participants 1, 3, 6, 9, 10, 11: yes, (A2) participant 2: on wrist position, but not on foot position, (A3) participants 4, 7: a little bit, (A4) participants 5, 8: no.

Q6: Your performance did change at some point(s) in the study. Why do you think this occurred? (A1) participant 1: I wanted to better my own ergonomic behavior, (A2) participants 2, 9: because I conducted observations, (A3) participant 3: sometimes I wanted to perform well for the data collector and sometimes I was really into my work. Sometimes I would just make my feet flat because it was the easiest, (A4) participant 4: because I received the information sheet, (A5) participant 5: my behavior still hasn’t
changed (she believed that the data the primary author showed her were false), (A5) participant 6, 7: I was made more aware by feedback, (A6) participant 8: I gained more knowledge of ergonomics with time, (A7) participant 10: because I knew I was being watched, (A8) participant 11: because I had a change deep within myself.

Q7: Was there anything that you said to yourself while you were being observed? (A1) participants 1, 2: the definition for shoulder and back position, (A2) participant 3: do well, but don’t make an obvious change, (A3) participant 4: no, but I was just more aware of the correct behaviors, (A4) participant 5: am I being safe, (A5) participants 6, 7, 8: no, (A6) participant 9: the definitions of all of the behaviors, (A7) participant 10: perform safely, (A8) participant 11: keep feet flat on the floor.

Q8: Was there something that you said to yourself each time you conducted an observation? (A1) participant 2: no, I just concentrated on the beeps (i.e., from the tape recorder, indicating when the observer should observe and record data), (A2) participants 5, 9: no, (A3) participant 6: I would critique the person according to the definitions which helped me to improve, (A4) participant 8: I questioned myself on my accuracy of back/shoulder judgments, (A5) participant 10: I tried to compare my posture with the posture of the person I was observing.

Q9: In the absence of feedback, did you find yourself wanting to be given information/feedback regarding your performance? (A1) participants 1, 2, 3, 4, 6, 7, 8, 9, 10, 11: yes, (A2) participant 5: no.

Q10: How do you think conducting observations changed your performance? (A1) participant 2: It increased my ability to know what I was supposed to do, especially on back/shoulders, (A2) participant 5: conducting observations did not arouse any thoughts for me, (A3) participant 6: it made me more aware that I might be doing some of the
same things, (A4) participant 8: it helped for me to be exposed to different models, (A5) participant 9: it helped me to improve my posture, (A6) participant 10: I don’t think that conducting observations changed my performance.

Q11: How do you think receiving feedback changed your performance? (A1) participants 1, 4: it made me want to do better, (A2) participant 2: I don’t think that receiving feedback changed my performance, (A3) participants 3, 5: it made me more conscious of the things I was doing wrong, (A4) participants 6, 9: it made me more aware of my performance, especially on shoulder/back position, (A5) participants 7, 8, 10, 11: it showed me the areas in which I needed to improve.

Q12: Were you comfortable having the investigators observe your behavior? (A1) participants 1, 2, 3, 4, 6-11: yes, (A2) participant 5: not at first, but eventually yes.

Q13: Were you comfortable having coworkers observe your behavior? (A1) participants 1, 3, 4, 7, 10, 11: yes, (A2) participants 2, 5, 6, 8, 9: not applicable (NA).

Q14: Were you more or less comfortable with coworkers or experimenters observing your behavior (was there a difference)? (A1) participants 1, 3, 4, 7, 10, 11: no, (A2) participants 2, 5, 6, 8, 9: NA.

Q15: Do you feel that you performed more safely after receiving feedback on your behavior? (A1) participants 1, 3, 4, 6, 7, 8, 10, 11: yes, (A2) participant 2: yes, especially on back/shoulder position, (A3) participant 5: no, (A4) participant 9: possibly.

Q16: Did you attempt to work more safely in the morning to increase your scores on the afternoon feedback? (A1) participants 1, 2, 5, 6, 7, 8, 11: no, (A2) participant 3: yes, but I tried even harder after I received feedback, (A3) participants 4, 9, 10: yes.
Q17: What did you think when you received high scores on your feedback? (A1) participants 1, 3, 4, 6-11: good job, (A2) participant 2: nothing, (A3) participant 5: I didn’t care.

Q18: What did you think when you received low scores on your feedback? (A1) participant 1: I mentally troubleshooted why they were low, (A2) participants 2, 4, 6, 10, 11: tried to remember how I was performing the target behaviors during that session, (A3) participants 3, 5: I didn’t care, (A4) participant 7: I wanted to know what about my positioning was wrong (more specific than the feedback sheet), (A5) participants 8, 9: I thought that I should work on the area in which I received a low score.

Q19: Was receiving high marks reinforcing for you? (A1) participants 1, 3, 4, 6-11: yes, (A2) participants 2, 5: I didn’t care.

Q20: Did receiving high marks motivate you to keep performing safely? (A1) participants 1, 3, 4, 6, 7, 9, 10: yes, (A2) participant 2: Yes, except on back/shoulder position, (A3) participant 5: I didn’t care, (A4) participants 8, 11: yes, but so did the knowledge of the benefits of reduced injury.

Q21: When you received low marks on a behavior did it make you want to “give up” on that behavior or did it make you want to try harder to improve it? (A1) participants 1, 2, 3, 4, 6-11: try harder to improve it, (A2) participant 5: I didn’t care.

Q22: Did you put any pressure on yourself to perform well? (A1) participants 1, 5, 6, 8: no, (A2) participants 2, 4: no, but I wanted to do well, (A3) participants 3, 7, 9, 10, 11: yes, a little bit.

Q23: Do you feel that the experimenters put any pressure on you to perform well? (A1) participants 1-8, 10: no, (A2) participants 9, 11: no pressure, but the experimenter’s presence provided an incentive to perform more safely.
Q24: Do you feel that you could have performed more safely if there were consequences in place for doing so (i.e.- receiving tokens for prizes, raffle tickets, or monetary consequences)? (A1) participants 1, 2, 4, 7: no, (A2) participants 3, 5, 6, 8-11: yes.

Q25: Do you feel that providing an ergonomic workstation to employees guarantees that they will perform more safely? (A1) participants 1-5, 7-11: no, (A2) participant 6: yes.

Q26: Do you feel that providing an ergonomic workstation to employees helps them to perform more safely? (A1) participants 1-11: yes.

Q27: Do you feel that someone in your position is at risk for a musculoskeletal disorder? (A1) participants 1, 2, 3, 5-10: yes, (A2) participants 4, 11: yes, especially carpal tunnel syndrome.

Q28: Do you think that you have any control over the attainment of a musculoskeletal disorder later in life? (A1) participants 1, 4, 7: I think I have the ability to reduce the risk but not prevent it, (A2) participants 2, 3, 5, 6, 8-11: yes.

Q29 (asked after follow up data collection): Your performance is better than it was when we stopped collecting data four months ago, any ideas as to why this is? (A1) participants 2, 3, 5: I know what to do, and I figured that if we didn’t do well enough last time and that’s what made you come back, then I would do it right this time (implying that they would perform well to prevent the return of the experimental data collectors), (A2) participants 4, 6: I figured that I would do it right since it was only going to be for 4 days, (A3) participant 10: I don’t know.
Q30 (asked after the follow up data collection): Your performance has not changed from when we stopped collecting data four months ago, any ideas as to why this is? (A1) participant 9: I don’t know, I’m just doing the best I can.

Q31 (asked after the follow up data collection): Your performance is not as good as it was when we stopped collecting data four months ago, any ideas as to why this is? (A1) participant 8: Not really, I guess I just haven’t been thinking about it as much.

Impact of Historical MSDs on Behavior Change
Each participant was asked if she had experienced any type of MSD prior to the beginning of the current study. Five participants noted that they had experienced pain in the past, and three of the five indicated that they had received medical treatment or advice for their injuries. Anecdotal evidence indicated that participant 2 was often unsafe on foot position due to sitting on one of her feet (placing one of her feet under her posterior while sitting). Participant 2 had undergone therapy for leg problems and a physical therapist recommended that she refrain from sitting on her feet while working at her desk. Participant 2 also reported that she had cracked her lowest vertebrae approximately two years before the study was conducted; however no causal information was obtained. A final comment made by participant 2 is that she had been experiencing wrist pain prior to the beginning of the current study, however she never sought medical assistance for this pain. Participant 3 underwent surgery in 1994 to correct a carpal tunnel injury in her right hand, and had surgery on her left elbow in 1996. Participant 3 also reported experiencing severe pain in her neck and shoulders at various times throughout her career. Participant 6 experienced tendonitis in 1999. In response to her medical claim she was taught stretches to reduce her tendonitis and was provided with a wrist cushion for her workstation. Participant 9 had reported experiencing pain in the form of a stiff
neck, and sore back and shoulders at various times throughout her career. She attributed these pains to her workstation, the duration of time she spent sitting down, and the way she sat in her chair at work. Participant 10 reported experiencing lower back pain at various times throughout her career, which she attributed to poor equipment (e.g., her chair) and poor workstation design (e.g., often working at a workstation where she was forced to turn her head and body to see her computer monitor). Participants 1, 4, 5, 7, 8, and 11 did not report experiencing any pain before the onset of the study, although the onset of pain during the baseline phase did cause participant 11 to seek her own information on ergonomics before the independent variable of information and training was administered.

Overall measures of behavior change were calculated for each participant by subtracting each participant's overall percent safe during baseline from her overall percent safe during the final phase in which data were collected (i.e., follow-up phase for participants 1-6, and 8-10, and the feedback phase for participants 7 and 11). Participant 1 had a difference of 42 percentage points; participant 2 had a difference of 44 percentage points; participant 3 had a difference of 32 percentage points; participant 4 had a difference of 29 percentage points; participant 5 had a difference of 20 percentage points; participant 6 had a difference of 41 percentage points; participant 7 had a difference of 25 percentage points; participant 8 had a difference of 31 percentage points; participant 9 had a difference of 43 percentage points; participant 10 had a difference of 48 percentage points; and participant eleven had a difference of 26 percentage points. The average improvement (calculated in percentage points) for those who had no historical record of MSDs was 28.8 percentage points, while the average improvement for those with a historical record of MSDs was 41.6 percentage points.
Interobserver Agreement

Interobserver agreement (IOA) was collected on 67% of all sessions (72 of 108 sessions). IOA averaged 96% across all behaviors for the morning sessions, and 96% across all behaviors for the afternoon sessions.

Morning Sessions

IOA between data collectors was collected on 80% of morning sessions (during 43 of 54 sessions). IOA averaged 98% on neck position (SD: 3.5; range: 84% - 100%) and 95% on back and shoulder position (SD: 6.3 range: 72% - 100%). On wrist position IOA averaged 94% (SD: 4.7; range: 78% - 100%), while averaging 98% on foot position (SD: 3.8; range: 80% - 100%). Overall IOA across all behaviors averaged 96% (SD: 3.8; range: 82% - 100%).

Afternoon Sessions

IOA between data collectors was collected on 54% of afternoon sessions (during 29 of 54 sessions). IOA averaged 98% on neck position (SD: 3.8; range: 84% - 100%) and 96% on back and shoulder position (SD: 3.8 range: 86% - 100%). On wrist position IOA averaged 93% (SD: 5.4; range: 72% - 99%), while averaging 97% on foot position (SD: 4.8; range: 75% - 100%). Overall IOA across all behaviors averaged 96% (SD: 3.5; range: 86% - 100%).
DISCUSSION

As an extension of Alvero and Austin (in press), one of the primary goals of the current study was to examine the effects of conducting observations on the behavior of the observer. Alvero and Austin (in press) sought to examine the same question in a controlled laboratory setting using college undergraduates as participants. The current study sought to replicate the effects obtained by Alvero and Austin (in press) in an applied setting using employees as participants. Additional goals of the current study were to assess the effects of information, performance feedback, and observer accuracy on the performance of ergonomic behaviors. Performance increases were commonly observed when participants were exposed to information and training, although the increases were maintained more frequently when participants conducted observations than when participants were observed without conducting observations. The results of the current study lend additional support to the notion that conducting observations of safety behavior will evoke safe behavior on the part of the observer. An analysis of the data also reveals a potential relationship between observer accuracy and safety performance. Results of the interviews conducted after the current study suggest the importance of verbal behavior in safety performance.

Baseline Performance

There was considerable reactivity observed during the baseline condition. This was partially due to a detailed participant consent form that all participants were required to sign at the onset of the study. The consent form indicated that the purpose of the study was to examine the observation process in behavior-based safety and mentioned that the
study was focused on reducing repetitive strain injuries. Quite notable is the fact that reactivity-like patterns were observed on back/shoulder position for all eleven participants. That is, at the beginning of baseline data collection all participants performed at high levels on back and shoulder position, but levels of performance began to decrease after a short time period (4-14 observation sessions, or 2-7 days). A plausible explanation for this phenomenon is that participant knowledge of ergonomics was sufficient for participants to assume that postural behaviors would be among those being measured, whereas foot position may not have been as obvious. Other trends that emerged in baseline were near ceiling performances for neck and wrist position (for example see participant 5: neck; participant 6: wrist). Environmental supports such as headsets for telephone use and wrist pads for typing were likely large contributors to such high levels of performance, as anecdotal evidence indicated that diminished performance on these measures mainly occurred in the absence of such environmental supports. It is also possible that high levels of performance were observed because the participants in this study were full-time working professionals with more experience engaging in the target behaviors, as opposed to the college undergraduates with less experience that have been used in previous studies (e.g., Alvero & Austin, in press). However, Culig (2002) also utilized full time experienced employees as participants in a similar study and did not observe levels of performance that were as high as those seen in the current study. It is worthwhile to note that Culig (2002) also used a stricter measurement of behavior by using a whole interval recording system in comparison to the momentary interval recording system used in the current study. The participants in the current study had been working on the job for a significant period of time, and had possibly been exposed to some type of training, or read some information on ergonomics, over the years. Although
both of these questions were asked during debriefing, it is possible that participants could not recall specific instances and therefore answered negatively to the questions.

Effects of Information

The provision of education and training about ergonomic behavior had little or no effects on wrist and neck position, as those behaviors were already close to ceiling performance (likely due to the presence of environmental supports or previous experience with the behaviors). The information phase generated small increases in performance on back and shoulder performance for participants 3, 7, 9, and 11. Positive effects were also seen on foot position for participants 1, 4, 6, 7, 9, 10, and 11, whereas temporary positive effects were seen for participant 8.

Effects of Conducting Observations

Of the six participant observers, none exhibited changes in performance on the dependent variables neck position and wrist position. As previously discussed, neck and wrist position scores were already close to ceiling performance for most participants. However, as a result of conducting observations, performance gains were apparent on back and shoulder position for participants 8 and 9, and also on foot position for participants 8, 9, and 10.

Effects of Receiving Feedback

Receiving feedback was the most effective independent variable in the sense that it increased performance on all four of the dependent variables. In other words, each of the dependent variables showed improvement for one or more participants in this group, whereas some dependent variables remained unchanged when exposed to other independent variables. Upon regular exposure to feedback, increases in performance
were observed: a) on neck position for participants 1 and 10, b) on back and shoulder position for participants 1, 3, 4, and 10, c) on wrist position for participant 10, and d) on foot position for participants 1, 3, 4, 7, 10, and 11.

Effects of Conducting Observations in Conjunction with Feedback

Participants who received feedback along with conducting observations also demonstrated improved performance in conjunction with the intervention onset. Increases in performance were observed: a) on neck position for participants 5 and 6, b) on back and shoulder position for participants 2, 5, 6, and 9, and c) on foot position for participants 2, 5, 6, and 9. No clear effects were observed on wrist position for any member of this group. At first, it appears as though the effects of this condition seem to be less robust than the provision of feedback in the absence of conducting observations. However, upon closer examination, the lack of greater effects could be attributable to the fact there were fewer behaviors in need of changing after conducting observations. Comparing the effects of observation alone with those of observation plus feedback was beyond the scope of the present study, however, future research might consider such a question by exposing different groups to the different treatments simultaneously.

Follow-up Performance

During follow-up data collection, which occurred approximately four months after the feedback was discontinued, all participants continued to perform as well as, or better than, their previous performance on all dependent variables, with the exception of foot position for participants 5 and 9. A short debriefing after the follow-up phase suggested that the presence of observers was an aversive condition for the majority of participants, and that performance had simply increased to expedite the departure of the experimental
observers. Participants’ responses suggest that they believed that they hadn’t performed well enough during the initial study, and so the experimental observers returned. In other words, employees appeared motivated to change behavior in order to remove the experimental observers. Participants who performed at similar or slightly lower levels during the follow-up condition did not indicate that the observer’s presence created an aversive condition.

Relationship Between Accuracy and Safe Performance

Researchers Hayes and Nelson (1983) suggested that all components of the self-monitoring procedure can affect behavior change, and in fact the only difference between self-monitoring and the monitoring of others could be the feedback provided when one monitors one’s own behavior. Hayes and Nelson argued that behavior change can still be achieved with inaccurate self-monitors, as participants are still exposed to other components of the self-monitoring procedure (i.e., instructions, recording devices, monitoring behaviors, etc.). However, Hayes and Nelson also hypothesized that increased accuracy when monitoring performance could increase levels of performance, as increased accuracy would result in an increase in the salience of some observation components, and thereby constitute a stronger intervention effect.

In an effort to assess the effects of increased observer accuracy on behavior change in the current study, correlation coefficients were calculated. Correlations between overall observer accuracy scores and overall percent safe scores were calculated on a daily basis for each day of the observation phase. To eliminate any confounds posed by analyzing sessions in which both components (i.e., feedback and observation) occurred, correlations were conducted only for sessions in which observations occurred without feedback. In this case, high correlation coefficients represent a strong
relationship between level of observer accuracy and the amount of behavior change on behalf of the observer. Finding a strong relationship between safety performance and accuracy would imply that behavior change is a function of being able to properly identify correct / incorrect postural positions. To suggest any causal relationship from the analysis would be incorrectly extrapolating beyond the results of the statistical test conducted; however identifying a non-causal relationship may warrant a more experimental analysis of the relationship.

As a statistic, correlation coefficients can tell us “how much of the total variance of one variable can be associated with the variance of another variable” (Hinkle, Wiersma, & Jurs, 1998, p.120). An adaptation of Hinkle Wiersma, and Jurs’ (1998) table designed to serve as a heuristic for interpreting the size of a correlation coefficient is presented below as Table 1.

Table 1
Interpreting the Size of a Correlation Coefficient

<table>
<thead>
<tr>
<th>Size of Correlation</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>.90 to 1.00</td>
<td>Very high correlation</td>
</tr>
<tr>
<td>.70 to .90</td>
<td>High correlation</td>
</tr>
<tr>
<td>.50 to .70</td>
<td>Moderate correlation</td>
</tr>
<tr>
<td>.30 to .50</td>
<td>Low correlation</td>
</tr>
<tr>
<td>.00 to .30</td>
<td>Little if any correlation</td>
</tr>
</tbody>
</table>

* Adapted from Hinkle, Wiersma, and Jurs (1998)

Although not all correlation coefficients were high, three of the six (50%) provide mentionable results. Participants 2, 6, and 8 provide for the interpretation of little if any correlation; participant 5 provides for an interpretation of a low correlation; the results of participant 9 indicate a high correlation; and the results for participant 10 indicate a very high correlation. The author believes that the low, high, and very high correlation
coefficient obtained in the current study warrant that further attention be paid to the importance of the accuracy of observations in future research studies.

If future research studies can demonstrate that performance increases as a function of observer accuracy, and observer accuracy can be improved given specific training conditions, then behavior-based safety practitioners can enhance the efficacy of the BBS process using the most suitable training techniques and conditions. As the current study primarily sought to evaluate the effects of simply conducting observations, the methodology used was not sufficient to determine the causes or effects of increased observer accuracy. Future studies should focus on determining the effects of increased observer accuracy, and if benefits are discovered in that domain, research should then focus on the enhancement of training methods to increase observer accuracy.

Possible Behavioral Functions

Contingency Analysis

Human beings need not be formally exposed to verbal statements surrounding a contingency, as the occurrence of the contingency itself may be sufficient for learning to occur. The process of learning through exposure to actual contingencies without the delivery or creation of rule statements (verbal descriptions of behavioral contingencies) is commonly known as contingency shaping, and produces what is called contingency-shaped behavior (Malott, Malott, & Trojan, 2000). Contingency-shaped behavior maintains because the organism comes into contact with the actual contingency, and Malott, Malott, and Trojan (2000) refer to this type of maintenance as contingency control.
In the current study, ergonomic behavior is a prime candidate to be classified as contingency shaped behavior for three reasons. Firstly, rules relating to ergonomics are rarely delivered without formal ergonomics training, and most participants indicated that they had never received any ergonomics training. Secondly, it is likely that the participants in this study had engaged in typing and sitting behaviors long before they had been exposed to any rules regarding such behaviors. And finally, although the reactivity seen with some employees implies that rules (verbal statements that specify contingencies) were being created, the quick return of behavior to baseline levels implies that the more immediate contingencies of engaging in the behaviors dominated any potential rule control, and that the behaviors were being maintained by contingency control. In a contingency control paradigm, the more immediate consequences in the environment have a greater influence over behavior than the more remote contingencies (Daniels, 1989; Skinner, 1953). In terms of ergonomics, contingency control could easily promote at-risk behaviors (i.e., slouched back and shoulders) with more immediate positive consequences (i.e., being comfortable) while putting safe behaviors (i.e., sitting upright) at a disadvantage by a lack of positive consequences, or by the provision of aversive consequences (i.e., being uncomfortable).

In more general terms, a person will engage in unsafe acts for two primary reasons. One reason is that the unsafe act often requires less response effort or avoids an aversive condition. The lower response effort could translate into walking a shorter distance, failing to use Personal Protective Equipment (PPE), non-use or misuse of guards on equipment, and so on, and aversive conditions could materialize as uncomfortable safety glasses, uncomfortable postural positions, unpleasant odors, etc. A second reason people may engage in unsafe acts is because the acts are followed by
immediate reinforcers, which can often come at the expense of increased risk of an incident or injury. Immediate reinforcers could be the decreased time that it takes to complete a job (thereby allowing an employee to leave early or move on to another task), or the termination of an aversive condition, such as dropping a heavy box from waist height instead of putting it down properly. In terms of bus operator safety, Olson and Austin (2001) conducted a contingency analysis of a bus operator failing to come to complete stops, mentioning a lower response effort in terms of decreased muscle exertion (in comparison to the muscle exertion required for a complete stop), and an increase in immediate reinforcement (e.g., forward movement), at the expense of the increased risk of an accident.

Olson and Austin’s (2001) contingency analysis uses a framework presented by Daniels (1989). The contingency analysis analyzes specific antecedent, behavior, and consequence (ABC) combinations to evaluate the consequence as either positive (P) or negative (N) (reinforcing or punishing); occurring immediately (I) or in the future (F) (describing the temporal relationship to the target behavior), and whether or not the consequence is perceived to be certain (C) or uncertain (U) (in terms of the probability of reinforcer or punisher delivery). Positive, immediate, and certain (PIC) consequences function as reinforcers and tend to increase or maintain behavior, whereas negative, future, and uncertain (NFU) consequences tend to decrease or eliminate behavior (Daniels, 1989; Olson & Austin, 2001). Daniels (1989) recommends doing two analyses for each performance, one for the problem (or at-risk) performance, and one for the desired (or safe) performance. As the majority of improvement was observed on the dependent variables “back / shoulder position” and “foot position”, those two dependent variables were chosen for the contingency analysis. The tables show both analyses
(problem and desired) for each of the two dependent variables, and display the consequences hypothetically available for that performance before and after the intervention. Table 2 shows an analysis of the problem performance of “back / shoulder position” and Table 3 shows an analysis of the desired performance of “back / shoulder position”. Analyses of at-risk and safe performance of “foot position” are shown in Table 4 and Table 5, respectively.
### Table 2
Analysis of the At-Risk Performance of Back / Shoulder Position

<table>
<thead>
<tr>
<th>Antecedents</th>
<th>Consequences</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone Rings</td>
<td>Assume a new, temporarily more comfortable position by leaning forward</td>
<td>PIU</td>
</tr>
<tr>
<td>Working with many papers at once</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Poor postural position (at the beginning of the observation)</td>
<td>No effort to alter body position required</td>
<td>PIC</td>
</tr>
<tr>
<td>Poor postural position (at the beginning of the observation)</td>
<td>Sense of upsetting the experimenters</td>
<td>NIU</td>
</tr>
<tr>
<td>Seated too close to desk</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Seated too far from desk</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Desk is too low</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Keyboard and / or mouse is too far from body</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Chair is improperly adjusted</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Trouble seeing the screen (i.e., due to a vision problem)</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Tired or weary (place elbows on desk)</td>
<td>Temporary relief from supporting body weight</td>
<td>PIC</td>
</tr>
<tr>
<td>Data collection procedures protected identities</td>
<td>No fear of punishment for poor posture</td>
<td>PIC</td>
</tr>
<tr>
<td>Received information and training on correct ergonomic behaviors</td>
<td>Generate verbal behavior regarding the importance of proper ergonomics</td>
<td>NIU, NFU</td>
</tr>
<tr>
<td>Conducted observations of participants behavior</td>
<td>Increased ability to identify improper ergonomic positions</td>
<td>NIU</td>
</tr>
<tr>
<td>Onset of feedback condition</td>
<td>Received poor feedback on ergonomic behavior</td>
<td>NF(hours)C (for most participants)</td>
</tr>
<tr>
<td>Experimental observers returned to the site after 4 months.</td>
<td>Perception that observers will remain if poor performance continues</td>
<td>NF(days)U</td>
</tr>
</tbody>
</table>

* Highlighted areas represent intervention conditions
Table 3
Analysis of the Safe Performance of Back / Shoulder Position

<table>
<thead>
<tr>
<th>Antecedents</th>
<th>Consequences</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone Rings</td>
<td>More effort required to reach for telephone</td>
<td>NIC</td>
</tr>
<tr>
<td>Working with many papers at once</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Poor postural position (at the beginning of the observation)</td>
<td>Less energy due to altering body position</td>
<td>NIC</td>
</tr>
<tr>
<td>Poor postural position (at the beginning of the experimenters observation)</td>
<td>No sense of upsetting the experimenters</td>
<td>PIC</td>
</tr>
<tr>
<td>Seated too close to desk</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Seated too far from desk</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Desk is too low</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Keyboard and / or mouse is too far from body</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Chair is improperly adjusted</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Trouble seeing the screen (i.e., due to a vision problem)</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Tired or weary (place elbows on desk)</td>
<td>Temporary relief from supporting body weight</td>
<td>PIC</td>
</tr>
<tr>
<td>Data collection procedures protected identities</td>
<td>No opportunity of reinforcement for good posture</td>
<td>NIC</td>
</tr>
<tr>
<td>Received information and training on correct ergonomic behaviors</td>
<td>Generate verbal behavior regarding the importance of proper ergonomics</td>
<td>PIU, PFU</td>
</tr>
<tr>
<td>Conducted observations of participants behavior</td>
<td>Increased ability to identify proper ergonomic positions</td>
<td>PIU</td>
</tr>
<tr>
<td>Onset of feedback condition</td>
<td>Received favorable feedback on ergonomic behavior</td>
<td>PF(hours)C (for most participants)</td>
</tr>
<tr>
<td>Experimental observers returned to the site after 4 months.</td>
<td>Perception that observers will depart if good performance continues</td>
<td>PF(days)U</td>
</tr>
</tbody>
</table>

* Highlighted areas represent intervention conditions
### Table 4
Analysis of the At-Risk Performance of Foot Position

<table>
<thead>
<tr>
<th>Antecedents</th>
<th>Consequences</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of foot stool</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Returned to desk (after being away from desk)</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Poor foot position (at the beginning of the observation)</td>
<td>No effort to alter body position required</td>
<td>PIC</td>
</tr>
<tr>
<td>Poor foot position (at the beginning of the observation)</td>
<td>Sense of upsetting the experimenters</td>
<td>NIU</td>
</tr>
<tr>
<td>Seated too close to desk</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Seated too far from desk</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Chair is improperly adjusted</td>
<td>Possibility of developing a MSD</td>
<td>NF(years)U</td>
</tr>
<tr>
<td>Data collection procedures protected identities</td>
<td>No fear of punishment for poor foot position</td>
<td>PIC</td>
</tr>
<tr>
<td>Received information and training on correct ergonomic behaviors</td>
<td>Generate verbal behavior regarding the importance of proper ergonomics</td>
<td>NIU, NFU</td>
</tr>
<tr>
<td>Conducted observations of participants behavior</td>
<td>Increased ability to identify improper ergonomic positions</td>
<td>NIU</td>
</tr>
<tr>
<td>Onset of feedback condition</td>
<td>Received poor feedback on foot position</td>
<td>NF(hours)C (for most participants)</td>
</tr>
<tr>
<td>Experimental observers returned to the site after 4 months.</td>
<td>Perception that observers will remain if poor performance continues</td>
<td>NF(days)U</td>
</tr>
</tbody>
</table>

* Highlighted areas represent intervention conditions

The contingency analyses indicate two recurring ratings that can inhibit proper ergonomic performance. One problem is that, by nature, cumulative trauma disorders can take many years before they become debilitating illnesses (hence the name, "cumulative"). If a person assumes an at-risk body position for a day, a week, or even a
year he or she may not experience any injuries, however the person is slowly increasing his or her chances of developing an MSD on a day-to-day basis.

Table 5
Analysis of the Safe Performance of Foot Position

<table>
<thead>
<tr>
<th>Antecedents</th>
<th>Consequences</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of foot stool</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Returned to desk (after being away from desk)</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Poor foot position (at the beginning of the observation)</td>
<td>Less energy due to altering body position</td>
<td>NIC</td>
</tr>
<tr>
<td>Poor foot position (at the beginning of the observation)</td>
<td>No sense of upsetting the experimenters</td>
<td>PIU</td>
</tr>
<tr>
<td>Seated too close to desk</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Seated too far from desk</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Chair is improperly adjusted</td>
<td>Slightly less chance of developing a MSD</td>
<td>PF(years)U</td>
</tr>
<tr>
<td>Data collection procedures protected identities</td>
<td>No fear of punishment for poor foot position</td>
<td>PIC</td>
</tr>
<tr>
<td>Received information and training on correct ergonomic behaviors</td>
<td>Generate verbal behavior regarding the importance of proper ergonomics</td>
<td>PIU, PFU</td>
</tr>
<tr>
<td>Conducted observations of participants behavior</td>
<td>Increased ability to identify improper ergonomic positions</td>
<td>PIU</td>
</tr>
<tr>
<td>Onset of feedback condition</td>
<td>Received favorable feedback on foot position</td>
<td>PF(hours)C (for most participants)</td>
</tr>
<tr>
<td>Experimental observers returned to the site after 4 months.</td>
<td>Perception that observers will depart if good performance continues</td>
<td>PF(days)U</td>
</tr>
</tbody>
</table>

* Highlighted areas represent intervention conditions

The “future” nature of the consequences in this setting favors the more at-risk contingency shaped behaviors.
Another problem identified by the contingency analysis is the uncertain nature of injury. It is theoretically possible, however unlikely, that a person could engage in poor postural positions for an entire lifetime and not experience an injury. The more uncertain a consequence, the less likely it is to influence behavior change (Daniels, 1989), and the small but cumulative nature of the behaviors leading to an aversive outcome (i.e., injury) do not provide enough aversion on any given instance of behavior to prevent recurrence of the behavior (Malott, Malott, & Trojan, 2000). Therefore, the more the contingency analyses reveal future and uncertain consequences, the less important the criterion of positive versus negative consequences becomes. In the current study, noticeable changes in participant behavior were more prevalent in the conditions in which more temporally proximal (i.e., a matter of hours or days as opposed to years) consequences were applied.

Post-Experiment Survey

The variety of behavior patterns observed during the study generated a post-experiment survey that was administered to participants during the debriefing session. One phenomenon of interest was the verbal behavior that participants generated concurrent with conducting observations. When asked, one half of the participant observers (participants 6, 8, and 10) indicated that they compared their own performance to the model (the observee) or made some self-evaluative statements while observing the model. Participants described the self-comparisons as visualizing their own behavior and what they look like while sitting at their own workstation, in comparison to the person they were currently observing during an observation session. Skinner refers to this phenomenon of visualization as “conditioned seeing” (Skinner, 1957, p. 158). Conditioned seeing is the process of visualizing stimuli (i.e., images) that are not actually present in the environment. In essence, participants were benefiting from both modeling
(conducting an observation) and self-evaluation via conditioned seeing, although the accuracy of the self-evaluation component was likely poor as it consisted solely of imagined stimuli. Hayes and Nelson (1983) would argue that such an occurrence of imagined stimuli and their probable inaccuracy would provide a lesser benefit than would be achieved using traditional self-modeling techniques that utilize video recordings of a participant’s behavior, however the formation and evaluation of such images would have a greater benefit than if no imagined stimuli were created at all.

Participant reports also indicate that conducting observations may effectively evoke self-monitoring responses. Also according to participant reports, self-monitoring responses were evoked while participants performed work duties at their workstations. At times, a participant may have identified one or more of his or her own behaviors that were at-risk, and then correct the at-risk behavior(s). Some participants reported recognizing some component of their behavior as at-risk and taking immediate steps to correct it. Other participants reported recognizing some component of their behavior as at-risk and choosing to ignore it, and instead choosing to maintain their current body position, which was more comfortable and required no response effort to change. Although participants reported identifying at-risk behavior both in the presence and absence of an observer, participants almost unanimously reported in increase in self-evaluation in the presence of an observer.

Two important, and as of yet unknown, variables that emerge from these reports are the frequency and content of participant verbalizations. Of the two unknown variables, it is likely that the content of self-verbalizations takes precedence over the frequency of such verbalizations, as some participants identified at-risk behavior yet made no efforts to correct such behaviors. Since the process of identifying at-risk
behavior is not sufficient enough to warrant a behavior change for all participants, one must look towards more rigorous research methods such as protocol analysis technology (e.g., Alvero, 2002) to assess the frequency, and more importantly the content, of such verbalizations.

As the current study was designed to detect the presence of an observer effect and did not employ protocol analysis technology, the experimental method used to assess participant verbalizations was participant interviews conducted at the conclusion of the study. During the interviews participants reported making verbalizations of a self-evaluative nature (i.e., "Am I performing safely on back/shoulder position?") and of an informational nature (i.e., reciting a behavioral definition for a particular dependent variable). Participants also reported giving themselves instructions through verbalizations such as, "Keep feet flat on the floor", or "Perform safely". Similarly, while conducting observations, participant observers primarily reported visualizing their own performance, and critiquing their own visualized performance as well as the performance of the model. The extent to which verbal behavior is generated by either observing or being observed, and the nature of such verbalizations, is a domain of research suitable for future research studies.

As previously discussed, an important variable affecting performance and behavior change may be the content of self-verbalizations. Self-verbalizations often take the form of a rule statement, and generate what is called rule-governed behavior. Malott, Malott, and Trojan (2000) define a rule as "a description of a behavioral contingency" (p. 391). Rule-governed behavior is then behavior that is controlled by a set of verbalizations describing contingencies, instead of the contingencies themselves. Rules are essential to human functioning. Rules allow people to state behavioral contingencies
and understand the consequences of their actions, without ever having to come in contact
with the actual consequence. For example, medicine bottles that state, “Taking two or
more pills within a 12 hour time period could cause dizziness, nausea, and vomiting”
inform the consumer of the behavior (taking two or more pills within a 12 hour time
period) and its potential consequence (the occurrence of dizziness, nausea, and vomiting).
Providing the consumer with the rule statement enables the consumer to avoid the
behavior that will lead to a potentially aversive consequence. In ergonomics, for
example, a person may state the rule, “If I type with my wrists in an improper position I
am at a greater risk of being injured”. Verbalizing this rule statement could create an
aversive condition, and if it were stated at the same time improper wrist position was
detected, this aversive condition would be paired with the improper wrist position, and
improper wrist position, or the verbal statement itself, could elicit an aversive condition.
To terminate this aversive condition (which could consist of something as simple as
thoughts of injury) the performer could engage in the proper wrist position. It is through
this mechanism that rule statements can influence behavior in the present, behavior for
which the natural contingencies may not occur for many years. In this case, the rule
statement allows the typist to contact an aversive condition, one that may motivate proper
typing position, without experiencing an actual injury. A rule statement could also
specify a more proximal consequence related to social factors, such as, “If I behave
unsafely, the observer will think less of me, or will give me negative feedback”. It is
possible that a rule statement of this nature could begin to influence behavior in an
experimental setting, and rules specifying outcomes related to injury could take over and
achieve a more lasting effect.
Realizing the importance of rule statements paves the way for future research in this area. If a participant in the current study generated rules that established at-risk body positions as aversive, one would hypothesize a greater change in behavior than if the participant did not create rules establishing at-risk body positions as aversive. If a participant failed to create such rules, an aversive condition related to at-risk behavior would be unlikely to exist, and a motivation for behavior change would be lessened. In the absence of rules related to at-risk behavior it is possible that behavior change could be attributed to other rules specifying more proximal contingencies, possibly rules pertaining to social consequences, as mentioned above. It is also likely that these rules would cease to exist in the absence of observer presence, and behavior change would be less durable. Future ergonomic studies should examine the extent to which these rules are created and rehearsed by participants. Future studies could also examine the effectiveness of training participants to rehearse experimenter-created rules, and the difference between rules pertaining to safety versus rules of a social nature.

Three specific instances of participant behavior were indicative of rule-generation in regards to feedback delivery, indicating that rules were generated in regards to feedback as well as ergonomic behavior. Participants 2, 4, and 10 displayed a trend in which afternoon scores were almost consistently higher than morning scores on back/shoulder position. Feedback distributed on any given day was based upon the performance observed during a morning observation session, and once poor feedback was received it may have served a rule-generating function. A participant could have created a rule such as, “I just received poor feedback, I should perform better”. However, even if participants did perform better during the afternoon sessions (e.g., participants 2, 4, and 10) they never received feedback on afternoon sessions, and so it is possible that
participants were seldom exposed to any feedback that indicated a high level of performance (e.g., participant 10 on back and shoulder position). Never receiving positive feedback on back and shoulder position deprived the participants of feedback that indicated they were performing the behaviors at least somewhat correctly.

The fact that all participants were informed that the feedback delivered in the afternoon was based on performance observed during the morning observation session creates another opportunity for verbal analysis. When participants were asked if they attempted to perform well during the morning session to increase the feedback scores delivered in the afternoon, an affirmative answer was received from participants 3, 4, 9, and 10. If a participant was trying to achieve positive scores on her feedback, she would intentionally perform well during the morning session. It is also possible that individuals performing solely to receive positive feedback would not perform to their greatest potential during an afternoon session, as no feedback was provided on afternoon performance. Someone creating rules of this type would likely exhibit a behavior pattern that displayed high performance during the morning sessions and low performance during the afternoon sessions. For this type of behavior pattern to emerge performance would have to be solely motivated by the feedback being delivered, and not by other potential motivating variables (i.e., the decrease in an aversive condition created by self-evaluative statements that indicated poor performance). None of the participants displayed such a behavior pattern, and in fact, participants 4 and 10 were amongst the three participants whose behavior showed a clear separation of higher performance during the afternoon sessions.
Modeling

An essential component of Performance-Based Instruction is guided observation (Brethower & Smalley, 1998). As discussed earlier in this paper, guided observation is an instructional phase in which a learner observes a model engaging in a task as a part of the process of learning the new task. Observing the behavior of another person (or model) is the first step in acquiring many of life's behaviors, such as walking, talking, or crossing the street. The value of watching another human being engage in a task can be two-fold. If the model engages in the task correctly the observer is provided with an example of appropriate behavior and a visual image of the desired performance. If the model inappropriately engages in a behavior, with proper training, the observer can identify the performance as a non-example and will be able to identify the incorrect components of the performance. Therefore, regardless of the quality of the model's performance, some direct benefits can be achieved by watching a model perform.

Answers given by participant observers during the debriefing session indicated that the participant observers used the model as a comparison figure, and therefore support Brethower and Smalley's (1998) claim of the importance of having a modeling component during skill acquisition. As previously discussed, some participant observers reported making self-evaluative statements while watching a model and specifically mentioned that watching a model assisted the participant observers in improving their own performance.

Impact of Historical MSDs on Behavior Change

The analysis conducted of overall performance gains indicated that participants that were previously (i.e., before the onset of the current study) exposed to MSDs
experienced higher overall performance gains than those participants that did not have a history of experiencing MSDs. Although overall composite measures were used in this analysis, further research could seek to discover which independent variables would have the greatest effects on particular dependent variables given certain participant characteristics. For example, future research may reveal that information and training alone are sufficient to increase a performance on which a person has experienced a related previous trauma (i.e., training would increase performance on correct wrist position given that a participant had experienced a carpal tunnel injury in the past), or a performance that is currently causing a participant discomfort (e.g., participant 11, who sought information on her own due to her discomfort). Future research might also indicate that a particular independent variable (i.e., information and training) is sufficient to improve performance on multiple dependent variables (i.e., wrist position, foot position, and back/shoulder position) given a history of a previous MSD injury of any type. Research could also seek to determine other participant characteristics (i.e., age, years on the job, etc.) that could assist in selecting the least intrusive but most effective independent variable as an intervention.

Strengths and Weaknesses of the Study

Strengths

One strength of this study is the high level of interobserver agreement achieved throughout the study. A total of eight experimental observers collected data for this study. On average, each observer collected data for two of the ten observation sessions held each week. Scheduling eight observers across ten shifts each week (two observers for most shifts) meant that observer pairings were very dynamic and almost every
observer conducted observations with every other. By establishing pairings in this manner the likelihood of observer bias and/or drift was greatly reduced. The levels of interobserver agreement attained were likely due to extensive observer training and a research protocol that required the experimental observers to spend five minutes reviewing the behavioral definitions before each observation session.

Another strength of this study was that the participants were real employees in an applied setting. Although great progress can be achieved in the lab due to the degree of control an experimenter can create, the social significance of applied behavior analysis is found in the application of behavioral principles to relevant populations (Baer, Wolf, & Risley, 1968). Applied settings create many new challenges for researchers, and along with those challenges come opportunities for the refinement of potential interventions. Although the effects seen in this study are less consistent than studies conducted in the laboratory, the social significance is greater in a sense that the participants have more to gain in terms of reduced risk of injury in their current occupation, in comparison to participants in a laboratory study that solely engage in the dependent variables for experimental purposes.

A final strength of this study is that it provided a first attempt at evaluating the effects of observer accuracy on performance. The initial observations and correlation coefficients suggest that some relationship may exist between observer accuracy and behavior change. The results of this study identify this area as a worthy candidate for further research studies. Future research studies should examine the extent to which accuracy is necessary to effect behavior change, or should identify the critical point at which accuracy encounters the law of diminishing returns in regards to behavior change,
so that observers could be trained to an appropriate level of competence at the least possible cost.

**Weaknesses**

Weaknesses of the current study include the fact that all participants were female. Participants of mixed genders (both male and female) would have been preferable, however no males worked in the research setting. Another weakness of this study is that it extended over such a time period that employees were given an opportunity to leave the research setting, resulting in a lack of experimental control. In this case the research setting was the employees' actual place of employment, and one cannot ask a participant to stay at work for four consecutive months without going home to their residence.

Although research in applied settings creates potential confounds in the area of decreased experimental control, it does provide the benefits of an increase in both face and social validity. In the current study a problem arose with participant 11, who had independently sought information on ergonomics before the ergonomics training phase was introduced. Participant 11 was experiencing some level of discomfort and referenced a tutorial on ergonomics found on a computer-based training program (i.e., for typists) presented in CD-ROM format. There was no way to prevent the participant from referencing the CD-ROM, and her discomfort in conjunction with her participation in an ergonomics research study likely prompted her to seek additional information. On a positive note, future researchers might investigate the extent to which behavioral interventions prompt participants to seek outside information, and under what conditions. By identifying and leveraging variables that increase participant involvement, it is likely that lasting effects could be achieved with less effort on the part of experimenters or practitioners.
Additional complications arose as the study progressed. Since the study was conducted in an actual work setting, participants took sick days, left early for personal appointments, and used vacation and training days. This lack of perfect attendance was further complicated by the criteria that the participant be a current employee of the hospital. Unfortunately participants 7 and 11 voluntarily ended their employment with the hospital in between the feedback and follow-up conditions, thereby eliminating the opportunity to collect follow-up data on their performance. Furthermore, participant 11 drastically reduced her hours at the onset of the feedback phase, and so participant 10 was instructed to cease conducting observations and become a non-observer participant. This change in observer status occurred as participant 10 was about to make the switch from an observation only phase into an observation plus feedback phase. However, due to her change to non-observer status, participant 10 only received feedback on her performance and did not conduct any additional observations. Participant 10’s switch to non-observer status balanced the number of individuals (N=2) conducting observations with the number of individuals (N=2) receiving feedback without conducting observations in that particular work area.

Another weakness encountered in the current study was the lack of experimental control over which participants used environmental supports (i.e., wrist rests, headsets, etc.), when, and for how long. Although participants had environmental supports that would assist them in performing safely, participants did not always use such supports. For example, during one observation session a participant may have used a headset to talk on the phone, but during another observation session the same participant may have used the telephone hand piece itself. When the hand piece is propped between the head and shoulder, a participant’s neck position becomes at risk. It is also possible that the use of
environmental supports was not consistent throughout a session. Anecdotal evidence gathered from experimental observers indicated that participants would use a footrest for a portion of the session, but not the entire session, thereby placing their foot position at risk for a portion of the session. The data collected would provide a more in depth look at the control of environmental variables if environmental support use was regulated, or if it was, at a minimum, recorded by experimental observers.

A final weakness of the current study is that participant observers were not exposed to the same model. Having participants observe different individuals (as opposed to having them view the same video series) creates a lack of control with regards to the quality of performance observed. Although the information and training phase contained a handout with good and poor examples of postural positions, in actual practice some participants may have been exposed to only good or poor examples of postural positions. Hayes and Nelson (1983) argue that all components of the observation procedure could have some effect on behavior, and so effects would be expected regardless of the quality of performance observed. However, the degree to which good and poor examples of performance are necessary to achieve optimal effects is unclear, and therefore applied studies using this methodology will encounter difficulty in determining the effects of conducting observations, and the effects of evaluating good or poor models. Future studies should examine the effects of observing safe versus unsafe models, possibly by having participants score videos of good and poor models to determine the value of each type of model, and hopefully to determine an appropriate combination thereof.
Future Research and Applied Implications

Future attempts at replicating the current research should address the weaknesses mentioned above. One such weakness that needs to be addressed is the inclusion of male participants to determine if any differences exist between male and female participants. Another desirable improvement to the current study would be having participants sign promise cards (for an example, see Boyce & Geller, 2000) in which participants promise to adhere to experimental procedures and agree not to seek outside information until the study has been completed.

Tighter experimental control is always desirable, but not always easy to achieve in applied settings. In addition to promise cards, experimental control could be enhanced by establishing control over the usage of environmental supports (i.e., headsets, wrist pads, etc.). Although the manipulation of the availability of such supports would constitute an independent variable in and of itself, accurate monitoring of usage during any particular observation session or interval could give great insight into the importance and effectiveness of such supports. In a similar manner, the adjustment of workstation equipment (i.e., chair and desk height, keyboard and mouse position) could be altered or at least assessed at regular intervals (e.g., Culig, 2002).

Although the current study makes a case for the value of observing a good or poor model, the value of observing one versus the other (or some combination of the two) has not been determined. As previously discussed, each participant observer was exposed to a different combination of safe and unsafe behaviors. It is possible that particular combinations of safe and unsafe model behaviors are superior to others, and future research should seek to detect such a combination so it can be regulated or assessed as an independent variable.
Finally, the area of verbal behavior warrants further exploration. Participants in the current study exhibited very unique patterns of behavior that may have been dependent on self-generated rules as opposed to experimenter-delivered independent variables. The results of this study clearly show the importance of analyzing verbal behavior and rules generated by a participant concerning his or her performance in a study. Further examinations of verbal behavior should seek to quantify what participants say, how often they say it, determine if conducting observations generates more verbal behavior than simply being observed, and document differences in the frequency of safety-related verbal behavior before, during, and after an observer is present. Research of this nature is currently being conducted by Alvero (2002).

Closing Comments

The results of this study indicate that a combination of training, conducting observations of safety performance, and receiving feedback on safety related measures can increase the safety performance of professional computer terminal operators in an applied setting. Results also indicate that conducting observations of safety performance may increase the safety performance of the observer. The current study indicates that future behavioral research in the area of ergonomics should focus on quantifying user/workstation interface measures and analyze the role that verbal behavior may serve in influencing safety performance.
Appendix A

Ergonomic Behaviors Training
Ergonomic Behaviors Training

The following definitions and pictures are representations of typical office behaviors being performed safely.

**Typing Behaviors: Wrist Position and Neck Position**

*Wrist Position* – Wrists should be in line with the elbows, not bent/extended upward or downward.

The following two pictures are examples of *incorrect* typing behavior.

This picture shows the typist with her wrists too low. This picture shows the typist with her wrists too high.

This picture shows the typist typing *correctly*, with her wrists floating freely over the keyboard and her wrists in line with her elbows.

*Neck Position* – The neck should be aligned with the back, and the eyes should be level with, or slightly above, the screen & document. The head should be upright.

Note: The head should not be slouched over, looking down at the keyboard, or turned to the side.
Here the worker is shown adjusting her screen so that her neck can be aligned with her back and her eyes can be level with the screen and the document. This is what the correct form of the behavior looks like.

**Sitting Behaviors:** Back / Shoulder Position and Foot Position

**Back / Shoulder Position** - Back should be upright, parallel to and up against the back of the chair. Shoulders should be in line with the back and hips.

Note: Back should not be leaning against the back of the chair; shoulders should not be slouched forward or arched backward.

Here the worker demonstrates the correct back and shoulder position.
Foot Position – Both feet should be flat on the floor (ball of foot and heel should touch floor or foot rest if a foot rest is used).

Note: Feet should not be resting on each other (or the opposite leg), on the legs of the chair, or underneath the body. Feet should not be raised so that they are resting on either the ball of the foot or the heel, causing the ankles to have a bent position.

Both of the pictures below show the correct foot position, (with and without the use of a footrest).

Additional Information:

- Changing postures throughout the workday will alleviate some of the discomfort associated with maintaining the same posture for extended periods of time.

- Since body type and workstations can vary a great deal, it is almost always necessary to make some modifications to a workstation in order to enable a person to perform safely. If you need help adjusting your workstation to enable you to perform safely please ask one of the investigators.

- If you would like to learn more about ergonomic behavior in the office environment visit http://www.pc.ibm.com/ww/healthycomputing/?.
Appendix B

Behavior Recording Form
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<tr>
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<th>Observer's Name:</th>
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<td>Feet</td>
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</table>

"+" Indicates that the behavior was performed safely during the interval
"-" Indicates that the behavior was not performed safely during the interval
"X" Indicates that the behavior was not applicable during the interval.
Appendix C

Ergonomic Behaviors Feedback Form
Ergonomic Behaviors Feedback Form

Your percentages of safe behavior during the last observation were:

___________% Safe on shoulder / back position.

- Performing safely on this measure requires your back to be upright, parallel to and up against the back of the chair (not leaning against it), and your shoulders to be in line with the back, not slouched forward or arched backward.

___________% Safe on foot position

- Performing safely on this measure requires your feet to be flat on the floor (ball of foot and heel should touch floor or foot rest if a foot rest is used).

___________% Safe on neck position

- Performing safely on this measure requires your neck to be aligned with the back, and your eyes to be level with the screen & document. Your head should be upright.

___________% Safe on wrist position

- Performing safely on this measure requires your wrists to be in line with the elbows, not bent/extended upward or downward.
Appendix D

Ergonomic Behaviors Quiz
Ergonomic Behaviors Quiz

Please respond to the following questions below.

1. To type safely, your wrists should be in line with what body part?
   a. Feet  
   b. Elbows  
   c. Back  
   d. Legs

2. It would still be considered ergonomically correct to type with your wrists bent/extended upward or downward. (Circle one)
   True False

3. To type safely the neck should be aligned with the _________.

4. To type safely the eyes should be level with the _____________.

5. Sitting correctly involves your back being parallel to the chair back. (Circle one)
   True False

6. While sitting correctly your shoulders should be in line with your _________.

7. While sitting correctly both the ball of your foot and your heel should make contact with the ____________ or a _________________.

8. You can avoid risk of injury as long as just one of your feet is in the correct position. (Circle one)
   True False
Appendix E

Informed Consent Documentation
I have been invited to participate in a research project entitled “An examination of the Observation Process in Behavior-Based Safety”. This research is intended to investigate the effects of conducting observations in the behavior-based safety process. This project is Joe Sasson’s Master’s thesis project. Dr. John Austin is his advisor, in the Psychology Department at Western Michigan University.

Participation Requirements: While the investigator is talking to me right now my eligibility to participate in this study will be determined. To participate I should: (a) intend on continuing my employment with Bronson Hospital for the next eight weeks, (b) be able to touch type fluently, (c) allow others to observe my behavior on the job as the experimenters in this study will be observing all participants for a behavior change, (d) agree to observe the behavior of other co-workers if called upon to do so, as one half of the participants chosen for this study will be asked to observe the behavior of their coworkers. By agreeing to participate in this study I am affirming that the above criteria are true, although I may withdraw from the study at any time for any reason without penalty.

Research Project Description: The purpose of the project is to examine the effects of the observation process in behavior-based safety in an attempt to make it better. This might help us to further advance the field and prevent repetitive strain disorders to individuals who engage in repetitive or static motion tasks, such as working at a desk or in an office. The duration of this project will be six to eight weeks depending on the data obtained.

Procedures of the Project: As a participant in this research project I may: (a) have my behavior observed by an investigator from Western Michigan University twice on a daily basis, (b) be exposed to training in the area of ergonomic behavior and be quizzed over the material and (c) be asked to observe and record the behavior of another coworker. If feedback is ever to be given to myself, or my coworkers, it will be delivered by one of the investigators. My total time commitment for this project may include a training session on ergonomic behaviors (approximately 30 minutes), and may include both the training in the use of a behavior recording form (approximately one hour) and conducting observations of co-workers behavior (each observation will last less than five minutes and will not exceed 25 observations). I may also be provided with feedback on my
behavior as a part of this study, and be asked to complete a questionnaire regarding my participation in this study once it has been completed. Lastly, the investigators may have access to the number of calls I answer per day to assess my work performance throughout the study. Although the actual requirements may be less than what is described here, they will not exceed what is described here.

Risks: Although this research involves minimal risk to me as a participant I understand that potential risks do exist. Potential risks of this study include an increase in stress due to added work demands as observing co-workers behavior is an additional task that is not included in the job description for this position. Participation in this project may involve additional time requirements as described above, and I will also be observed as a component of this study. Being observed at work or the mere presence of observers in my workspace may cause some uneasiness on the job. Additionally, there may be a risk that I may be subject to jealousy or scrutiny from my co-workers because not all employees will be able to participate in this study. Furthermore, although the data obtained in this study will remain confidential, it is not possible to protect the identity of the participants in this study as others in the work area (coworkers and the supervisor) will be able to see the participants being observed by another person or conducting observations themselves. The best way to minimize the risks stated above is to have open communication with the investigators. If I feel that I am experiencing any of the symptoms listed above I know that I can contact Joe Sasson or Dr. John Austin to let them know as soon as possible. Joe Sasson or Dr. John Austin will immediately take steps to remedy the situation or discuss removing me from the study to terminate the negative side effects. As in all research there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate measures will be taken; however, no compensation or additional treatment will be made available to the subject except as otherwise stated in this consent form.

Benefits: I understand that the working conditions I am currently exposed to place me in a position where I could be at risk for a repetitive strain disorder later on life. This project plans to provide me with ergonomics training that may help me to perform common behaviors correctly so that I may reduce my chance of developing a repetitive strain disorder later in life. I am also aware that this project may have a lasting impact on the workplace after the project is completed if Bronson Hospital decides to implement any projects based on the findings of this study.

Confidentiality: All information obtained in this study will remain strictly confidential. This includes all data presented to any employee of Bronson Hospital, and data provided to WMU researchers by Bronson Hospital. A number will be assigned to me and will be used to identify my data. If the results are publicly presented I will not be identified by
name. By signing this consent form I am giving permission for the data obtained in this study to be presented anonymously in professional presentations and publications. If chosen to participate in this study I will not discuss what I have observed with others, and I will not keep any written records of any observations. I will not provide any information on my behavior or the behavior of another participant to my supervisor or another coworker. I further understand that the information obtained in this study is not to be used in any performance evaluations.

However, as a part of this study I may be observed by a coworker, which could have potential impacts in the workplace if that coworker is asked to comment on my behavior and breaches the confidentiality to which they, and I, have agreed to maintain.

**Voluntary participation:** My participation in this study is completely voluntary and will not affect, in any way, my work evaluation of job performance. My supervisor and/or coworkers will not be informed of my behavior during the study. I am free to withdraw at any time without penalty. My participation in this study, or my withdrawal from it will not affect my relationship with Western Michigan University or my employment status with Bronson Hospital. At the end of the study the investigator will answer any questions that I have and will explain how my data helped them to learn more about the observation process in behavior-based safety. Although I am giving consent to be a participant in this study, I realize that there is a chance that I may not be called upon to participate.
Who to contact with questions: If I have any questions about this study I may contact Joe Sasson at 353-1687. In addition, Dr. Austin, his faculty advisor, can be reached at 387-4495. I may also contact the chair of the Human Subjects Institutional Review Board at 387-8293 or the vice president for research at 387-8298 if questions or problems arise during the course of the study.

This document has been 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. Participants should not sign this document if the corner does not have a stamped date and signature.

My signature below indicates that I have read and/or had explained to me the purpose and requirements of the study and that I agree to participate.

<table>
<thead>
<tr>
<th>Participant Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

Consent obtained by:

<table>
<thead>
<tr>
<th>Initials of researcher</th>
<th>Date</th>
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</thead>
</table>

_Please keep the second copy of this form for your records._
Appendix F

Debriefing Script
Debriefing Script

Following the last session of participation the student investigator will go through all of the items on this list with each of the participants individually.

1. Thank the subject for participating the research study.

2. Ask the participant questions about their participation in the study and any previous exposure they may have had to ergonomics training.

3. Explain the purpose of the study as follows:
   a. Behavior-based safety has been shown to be a very effective method for increasing safe behavior in the workplace for over 30 years.
   b. Conducting observations is a large portion of the behavior-based safety process.
   c. The research question was, “Do observers perform more safely as a function of conducting observations?”
   d. A lab study has shown that the answer to the research question is yes, that conducting observations does increase the safe performance of the observer.
   e. This study was the first attempt at examining this research question in an applied setting.
   f. If the results of the lab study are replicated in the findings of the present study it will be explained that this could alter the way in which the behavior-based safety process is implemented and that if additional research also finds similar conclusions then having employees conduct observations should be a part of every behavior-based safety implementation.
   g. Ask if they understand this or if they have any additional questions.

4. Show the participant graphs of his/her performance and ask the participant if they have any questions about their performance.

5. Explain how the participant’s performance relates to the research question (e.g. did the participant perform better when conducting observations of co-workers behavior)

6. Ask the participant if he/she has any questions regarding participation in the project. Answer those questions.

7. Thank the participant again for their cooperation and participation in the study.
Appendix G

Debriefing Questions
Debriefing Questions

Questions asked during the debriefing session.

1. What did you think was being measured before you received the information on ergonomics?
2. Did you find yourself thinking about safety when you were being observed?
3. Did you find yourself thinking about safety when you were not being observed?
4. What did you think the purpose of conducting observations was?
5. Do you think your behavior changed throughout the course of the study?
6. Your performance did change at some point(s) in the study. Why do you think this occurred?
7. Was there anything that you said to yourself while you were being observed?
8. Was there something that you said to yourself each time you conducted an observation?
9. In the absence of feedback, did you find yourself wanting to be given information/feedback regarding your performance?
10. How do you think conducting observations changed your performance?
11. How do you think receiving feedback changed your performance?
12. Were you comfortable having the investigators observe your behavior?
13. Were you comfortable having coworkers observe your behavior?
14. Were you more or less comfortable with coworkers or experimenters observing your behavior (was there a difference)?
15. Do you feel that you performed more safely after receiving feedback on your behavior?
16. Did you attempt to work more safely in the morning to increase your scores on the afternoon feedback?

17. What did you think when you received high scores on your feedback?

18. What did you think when you received low scores on your feedback?

19. Was receiving high marks reinforcing for you?

20. Did receiving high marks motivate you to keep performing safely?

21. When you received low marks on a behavior did it make you want to “give up” on that behavior or did it make you want to try harder to improve it?

22. Did you put any pressure on yourself to perform well?

23. Do you feel that the experimenters put any pressure on you to perform well?

24. Do you feel that you could have performed more safely if there were consequences in place for doing so (i.e.- receiving tokens for prizes, raffle tickets, or monetary consequences)?

25. Do you feel that providing an ergonomic workstation to employee’s guarantees that they will perform more safely?

26. Do you feel that providing an ergonomic workstation to employees helps them to perform more safely?

27. Do you feel that someone in your position is at risk for a musculoskeletal disorder?

28. Do you think that you have any control over the attainment of a musculoskeletal disorder later on life?

29. (asked after follow up data collection): Your performance is better than it was when we stopped collecting data four months ago, any ideas as to why this is?

30. (asked after the follow up data collection): Your performance has not changed from when we stopped collecting data four months ago, any ideas as to why this is?
31. (asked after the follow up data collection): Your performance is not as good as it was when we stopped collecting data four months ago, any ideas as to why this is?
Appendix H
Site Approval Letter
Date: November 15, 2000

To: James W. Carter, MD
   Chairperson, Human Use Committee
   Bronson Center for Clinical and Community Research
   One Healthcare Plaza, Box 42
   Kalamazoo, MI 49007

From: Heather Adams
   Director of Patient Accounting and Scheduling
   Bronson Methodist Hospital
   One Healthcare Plaza
   Kalamazoo, MI 49007

Subject: BMH 2000-0032, "An Examination of the Observation Process in Behavior-Based Safety"

Principal Investigator: John Austin, PhD
Collaborating Investigator: Joseph R. Sasson

The purpose of this memo is to endorse a research study that will be conducted at Bronson Methodist Hospital in the patient accounting and scheduling departments. Dr. Austin, Mr. Sasson, and I have discussed in detail, the procedures of the study. I believe that the proposed research will not adversely impact the performance or well-being of the employees who choose to volunteer for this project.

I understand that Bronson Methodist Hospital may terminate this investigation at any time and for any reason, without penalty. I understand the Human Use Committee at Bronson Methodist Hospital has approved the investigation pending this endorsement.

If you have further questions regarding this investigation, please feel free to contact me.

cc: John Austin, PhD
Appendix I

Protocol Clearance from the Human Subjects Institutional Review Board
Date: January 12, 2001

To: John Austin, Principal Investigator
    Joseph Sasson, Student Investigator for thesis

From: Michael S. Pritchard, Interim Chair

Re: HSIRB Project Number 00-11-04

This letter will serve as confirmation that your research project entitled “An Examination of the Observation Process in Behavior Based Safety” has been approved under the full 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: November 22 2001
BIBLIOGRAPHY


Occupational Safety and Health Administration [OSHA] (1999b). Preventing work-related musculoskeletal disorders. OSHA website. Available:  


