

A Comparison of Feedforward versus Feedback Interventions for Safety Self- Management in Mining Operations

Thesis submitted to the faculty of Virginia Polytechnic Institute and State University
in partial fulfillment of the degree
MASTER OF SCIENCE

in

Psychology

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April 12, 2002
Blacksburg, Virginia

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ABSTRACT

This quasi-experimental field study examined the efficacy of a safety self-management intervention to increase safety-related work practices in mining operations. A total of 15 male miners participated in the study while engaging in their normal work practices at the Virginia Tech Quarry, located in Blacksburg, Virginia. The study had two groups, *Feedforward* ($n=8$)--participants self-recorded their intentions to engage in specific percentages of safety-related work behaviors *before* starting their shift for the day, and *Feedback* ($n=7$)--participants self-recorded their percentages of safety-related work behaviors *after* their shift for the day.

After a seven-week Baseline, miners participated in a safety training presentation. Immediately following this training, participants from each group were instructed to complete one self-monitoring form each day on their self-intentions (Feedforward) or actual (Feedback) safety performance for four weeks. Participants were paid \$1.00 for each completed self-monitoring form. All completed forms were entered into a raffle for a cash prize of \$50.00 at the end of the Intervention phase. During Withdrawal (four weeks) miners did not complete any self-monitoring forms.

Trained research assistants made a total of 10,905 obtrusive behavioral observations on three target behaviors (ear plugs, dust mask, and safety glasses) and five non-target behaviors (gloves, hard hat, boots, knee position during lifts, body position during lifts) across phases. Results showed the safety self-management intervention significantly increased safety performance across both target and non-target behaviors during the Intervention phase.

ACKNOWLEDGEMENTS

The acknowledgments section is my opportunity to thank those individuals who made this research possible, and it's also my opportunity to thank those who have guided, motivated, and financed my academic career. I would never be at this prestigious University if it weren't for the determined and committed upbringing by my parents, Larry Hickman and Sandra Snyder. It was their foresight that I have the opportunity to receive a good education. They paid for four and a half years of education at the University of Florida and allowed me the opportunity to focus on my studies (i.e., I didn't have to hold a job).

More specifically, I'll never forget my mother and stepfather's desire that I discover my own beliefs and values. You both instilled in me a motivation to succeed, and allowed me to take risks and make my own mistakes. It has paid great dividends. My father and stepmother, Marion, have been there at every step. They have given me so much emotional support and believed in me the whole time. They always looked out for my best interests (Pops, maybe I can get some sleep now). I can only hope when I have children I can raise them as well as you all raised me.

I'd like to thank the rest of my family members who have supported me during my long academic career. Grandma Hickman, Grandma Berkowitz, Chid, Mrs. B, and Sharon, thank you so much for your support, I love you all. A special thanks and prayer to my recently deceased grandfather, Seymour Berkowitz. I'm deeply saddened by his passing, the world had lost a great man, and it pains me he and Grandpa Hickman were not able to be present for this accomplishment (but their spirit will always be with me).

How do I thank my advisor and mentor Dr. Scott Geller? Words are such an injustice to describe the guidance you have provided me. This thesis would not be possible without you

(literally I wouldn't have had this opportunity if you hadn't given a talk with Virginia Tech's Health and Safety Office). The professional, and more importantly, timely manner in which you provide feedback is truly something to model. I know I complain when I get back a paper swimming in red ink, but I appreciate every pen stroke. You're the reason I came to Virginia Tech. You make the learning process interesting and truly care about your student's professional and personal life. Your zest for life, research, and productivity is intoxicating.

I would also like to thank the rest of my committee, Dr. Jack Finney and Dr. Richard Winnet, for their valuable feedback, support, and guidance (allowing me to change thesis topics after my original proposal fizzled). They were extremely considerate and caring during this difficult time.

I'm also greatly indebted to my girlfriend, Ashleigh. She was more understanding than I would have been during this time. We didn't get to see much of each other, but she understood and rarely complained. Those long weekends watching me work on the computer couldn't have been much fun. Without your support, love, respect, and encouragement I would have been one depressed man. I love you baby!

I own a large debt of gratitude to Albert Moore. Albert had the insight to allow me to work with the miners at the Virginia Tech Quarry. He also allowed me to use his facilities for training, and supplied and trained our research assistants with proper hearing protection. He actively cared for the health and safety of the miners and research assistants. Albert, I owe you one (if not more)!

I would also like to thank all the members of the Center for Applied Behavior Systems (CABS). They made this research project an absolute joy to manage. I thank our lab coordinator, Ian Ehrhart, for all the copying and grunt work he did related to this project. He did

everything in a timely and professional manner, going beyond the call of duty. I would like also to thank all the graduate students, Chris Dula (for his support and guidance), Angie Krom Fournier (she paved the way ahead of me, making this thesis project much easier), Phil Lehman (you truly believed and supported me), and Kelli England Will (your work ethic and bubbly personality was a pleasure). To all the CABS undergraduate research assistants who worked on this project, I owe a tremendous debt of gratitude, they are: Thomas Carpenito, Trey Church III, Andrea Cincotta, David Grandin, Beverly Kain, Stephanie Krepinevich, Lauren LeHew, Erica Petrazzuolo, Shannon Rosti, Hillary Sewell, Tara Smith, Michael Taliaferro, Matt Hargrove, and Tiffany Tanner.

Last, but certainly not least, are my two best friends in Blacksburg, Chuck Pettinger and Josh Williams. Josh and Chuck have been indispensable with their professional knowledge and guidance. Chuck provided me with valuable assistance in conducting my analyses and using SPSS (does that thing come with an instruction manual that works?). Josh was instrumental in keeping me focused and allowing me to see the light at the end of the tunnel. Both are good friends, and people (I had to say something nice because their helping me move), and I hope to join you both on the golf course very soon (after I finish my work and get some sleep).

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INTRODUCTION

The Problem

Injury is the principle cause of lost-person years of productive life in the U.S. and accounts for more years of lost potential than cancer and cardiovascular disease combined (Waller, 1987). In 2000, 533,500 American employees were injured and 5,915 were fatality injured while working, resulting in an estimated \$62.5 billion dollars in medical attention (U.S. Bureau of Labor Statistics, 2001b). Every year, more than 80,000 Americans are permanently disabled by work-related injuries. In fact, injuries are the leading cause of death of individual's aged 44 and less in the U.S. (Baker, Conroy, & Johnston, 1992). Clearly, injuries occurring on the job due to unsafe (or at-risk) work behaviors remain a significant problem nationwide (Baker *et al.*, 1992).

Significance to Mining

In the mining industry alone, 510 workers were killed in both metal/non-metal and surface/underground coal mines from 1990 to 1999 (Mine Safety and Health Administration, 2001a). In 2000, 5% of all work-related fatalities occurred in mining facilities, yet mining employment only represents .6% of the total workforce in the U.S. (U.S. Bureau of Labor Statistics, 2001a). Also, there were 64,200 reported injuries by miners in 2000 (U.S. Bureau of Labor Statistics, 2001c). More specifically, above-ground mines had 83 fatalities and 15,317 injuries in 2000 (Mine Safety and Health Administration, 2001b). In 2000, the mining industry recorded a rate of 30.0 fatal injuries per 100,000 workers, the highest of any industry and about 7 times the rate for all workers in the U.S. (U.S. Bureau of Labor Statistics, 2001b). It is likely these numbers grossly underestimate the actual number of miners hurt on the job because so many injuries are unreported or hidden (Miller, 1997).

Social and Economic Ramifications

In addition to the traumatic personal consequences experienced by employees and their friends and families due to unexpected industrial injuries and deaths, there are also critical social and economic consequences to consider. Although the severe pain and suffering caused by these misfortunes cannot be easily estimated, the social and economic costs can be estimated. These costs include lost wages, medical expenses, insurance claims, production delays, lost-time of coworkers, equipment damage, fire losses, and indirect costs (National Safety Council, 1988, 1994, 1995).

The overall cost of work-related injuries incurred back in 1989 has been estimated at \$48 billion (Baker *et al.*, 1992). This figure is an increase from the 1987 estimate of \$42.4 billion and is dramatically larger than the 1985 estimate of \$34.6 billion (National Safety Council, 1988). Although all of these estimates are enormous, the numbers also indicate the cost of industrial injuries is increasing at an alarming rate. And, it is likely these numbers underestimate the true impact of industrial injuries because of problems with current surveillance techniques and the fact many injuries are not reported (Baker *et al.*, 1992; The National Committee for Injury Prevention and Control, 1989; U.S. Bureau of Labor Statistics, 1997).

Self-Management

Self-management (Mahoney, 1971, 1972) is a behavior-based (BB) improvement process whereby individuals change their own behavior in a goal-directed fashion by: a) manipulating behavioral antecedents, b) observing and recording specific target behaviors, and c) self-administrating rewards for personal achievements (Geller & Clarke, 1999; Kazdin, 1993; Watson & Tharp, 1997).

The practical benefits of self-management processes have been demonstrated in numerous clinical settings, most notable in the reduction of alcohol consumption (Garvin, Alcorn, Faulkner, & Kim 1992; Sitharthan, Kavanagh, & Sayer, 1996; Sobell & Sobell, 1995), weight control (Baker & Kirschenbaum, 1993), and the cessation of smoking (Curry, 1993; Shiffman, 1984). Unfortunately, the potential benefits of using self-management techniques to improve safety-related work behaviors have not been evaluated systematically. In fact, the author's review of the research literature indicated no published studies that investigated the efficacy of using self-management to improve safe work practices. Yet, one can imagine the practical benefits of using self-management interventions to increase safety-related work behaviors with workers who have little oversight or work by themselves (i.e., solitary workers).

Self-management strategies. Research indicates five self-management procedures can facilitate behavioral improvement, including: a) activator management (Heins, Lloyd, & Hallahan, 1986), b) social support (Stuart, 1967), c) goal setting (Latham & Locke, 1991; Latham & Yukl, 1975; Locke & Latham, 1990), d) self-observation and self-recording (Ericsson, Krampe, & Tesch-Romer, 1993; Lau, Bradley, & Parr, 1993), and e) self-rewards (Sohn & Lanal, 1982).

Activator management involves identifying environmental, behavioral, and personal factors that precede the occurrence of safe and at-risk behaviors. Strategies are then employed to eliminate activators that precede at-risk behaviors and add activators that will increase the probability of safe behaviors (e.g., reminder messages that specify a target behavior).

Creating a supportive interpersonal climate can also improve the success of a BB self-management intervention (Stuart, 1967). Sources of social support can involve supervisors, coworkers, friends, and family who can encourage performance of the targeted behaviors

(Heinzelman & Bagley, 1970; Lawson & Rhodes, 1981; Moss & Arend, 1977). For example, social support can include prompting and positive feedback for personal achievements (Perri & Richards, 1977).

Specific BB goals should be: a) set high, yet b) be achievable, c) specify expectations for improvement, and d) include the tracking of progress (Geller, 1996, 1998b, 2001b; Geller & Clarke, 1999).

Regularly engaging in the self-observation and self-recording of specific behaviors is also a key component of self-management (Bagozzi, 1992; Kazdin, 1993). Social cognitive theory (Bandura, 1991) suggests self-observation is one of the primary components of behavior change through self-regulation. According to Bandura (1991), critical elements in the application of self-observation include specific self-set goals, and a belief in the “value” of behavior change. Research also indicates perceptions of choice, and increased self-awareness of specific behaviors, can focus an individual’s attention on behavior improvement (Binswanger, 1991).

Self-observation involves observing one’s own behaviors soon after they occur, as well as noting related environmental events that precede and follow the target behaviors (Watson & Tharp, 1997). Recording the occurrence of safe and at-risk behaviors provides an objective record of current safety performance, and charting progress toward reaching specific BB safety goals provides feedback on accomplishment, and identifies areas for improvement.

Characteristics of successful and unsuccessful self-management programs. A review of the self-management research literature by Cromier and Cromier (1991) points out a number of factors associated with successful versus unsuccessful self-management programs. Successful self-management was associated with: a) using a combination of strategies that focus on antecedents, such as goal setting and reminders, self-observation, and consequences or self-

reward (Mahoney, Moura, & Wade, 1973; Perri *et al.*, 1987), b) BB goal setting and feedback concerning progress toward goal attainment (Nelson, 1977), c) BB social support from individuals who come in daily contact with the self-manager (McCaul, Glasgow, & O'Neill, 1992), and d) the consistent and regular use of multiple BB self-management strategies to maximize improvement and ensure long-term behavioral improvement (Hefferman & Richards, 1981; Perri & Richards, 1977).

Unsuccessful applications of BB self-management are associated with: a) targeting too many behaviors at the same time (Nelson, 1977), b) soliciting insufficient social support (Peterson, 1983; Wood, Hardin, & Wang, 1984), c) using only a single self-management strategy (Holman & Baer, 1979; Perri *et al.*, 1987), d) inconsistent or sporadic observations or recording of the target behavior(s) (Thorensen & Mahoney, 1974), and e) failing to set challenging and attainable goals (Perri & Richards, 1977).

Implementing self-management programs. Self-management is typically a six-step process, including: a) identification of target behaviors (Cervone & Wood, 1995); b) establishment of a behavioral baseline using self-observation to identify antecedents and consequences associated with the occurrence and non-occurrence of the target behaviors (Cromier & Cromier, 1991); c) selection of a BB self-management strategy to promote desired behavior change and chart progress; d) selection of a BB goal that is specific, motivational, attainable, relevant, and trackable (Geller, 2001a); e) self-observation and self-recording of target behaviors to measure progress toward reaching the goal (Kirschenbaum, Ordman, Tomarken, & Holtzbauer, 1982), and f) administration of self-rewards that are accessible, individualized, valued, varied, and follow the targeted behavior as immediately as possible (Cromier & Cromier, 1991).

Once target behaviors have been identified, a “manageable” number of behaviors should be selected for improvement (Kirby, Fowler, & Baer, 1991). While there is no available prescription for the optimal number of behaviors to observe, the self-management literature suggests it is better to start with a few behaviors and build, than to tackle a myriad of behaviors which may lead to distress or discouragement (Cromier & Cromier, 1991; Watson & Tharp, 1997).

Once target behavior(s) are selected, a BB self-management strategy is developed. As discussed above, numerous self-management strategies are available and the success of BB self-management is positively correlated with the number of strategies used (Watson & Tharp, 1997).

Goal setting should follow the SMART acronym: Specific, Motivational, Achievable, Relevant, and Trackable (Geller, 2001a). The goal should specify the behavior(s), the desired change, and the time period in which the goal will be achieved (Latham & Yukl, 1975; Locke & Latham, 1990; Latham & Locke, 1991). The Behavior Change Taxonomy (Geller, 1998a) and prior research (Geller, 1998b; Ludwig & Geller, 1997, 1999, 2001) indicates that allowing individuals to set their own goals will increase the effectiveness of self-management.

In general, the greater the frequency of self-observing and recording per behavior, the greater the impact of the process (Baker & Kirschenbaum, 1993). However, the length of time BB self-monitoring should occur to ensure response maintenance varies across situations and behaviors. In most cases self-observations should continue for at least three to four weeks (Kirschenbaum *et al.*, 1982).

Goal-setting theory. Locke and Latham (1990) are credited with most fully presenting goal-setting theory. The attributes and approaches of successful goal-setting strategies have been delineated above. Strong support has been found for two of Locke’s (1968) main postulates: a)

difficult goals lead to higher levels of performance than easy goals, and b) specific (i.e., I will increase my safety-belt use by 50%), difficult goals lead to higher performance than vague (I will do my best), difficult goals (Mento, Steel, & Karren, 1978; Tubbs, 1986).

Task complexity may also moderate the relation between performance and goal setting (Latham & Locke, 1991). Many field experiments have documented the beneficial effects of goal setting, among such workers as: loggers (Latham & Kline, 1974), woods workers (Latham & Yukl, 1975), ship loading and canning employees (Migliore, 1977), die casters (Adam, 1975), telephone service workers (Hamner & Harnett, 1976), and maintenance technicians (Ivancevich, 1977).

On the other hand, Boyce and Geller (1999) were unable to increase safety-belt use among industrial workers with BB goal setting. The authors indicated that assigning the goal (rather than involving workers in setting the goal) contributed to the absence of an intervention effect. A meta-analysis (Neubert, 1998), comparing goal setting to goal setting and feedback, showed that adding feedback to goal setting contributed substantially to intervention impact.

Feedback. Performance feedback can be based on individual or group performance, and reported specifically per individual behavior or globally as a summary of individual behaviors (Williams & Geller, 2000). It can be delivered individually or in group settings, and is often combined with education and/or training (e.g., Zohar, Cohen, & Azar, 1980) and goal setting (e.g., Cohen & Jensen, 1984; Saarela, 1990). The behavior change literature has shown beneficial effects of publicly posting information that displays the performance levels of a community or work group. For example, Van Houten and his colleagues (Van Houten & Nau, 1983; Van Houten, Nau, & Marini, 1980) found that community signs posting the daily percentages of drivers exceeding the speed limit increased the percentage of drivers who

subsequently complied with the speed limit. Similarly, Jonah (1989) and Geller (2001a) reported significant increases in safety-belt use following the posting of roadway signs that displayed "percentage of drivers wearing seat belts yesterday."

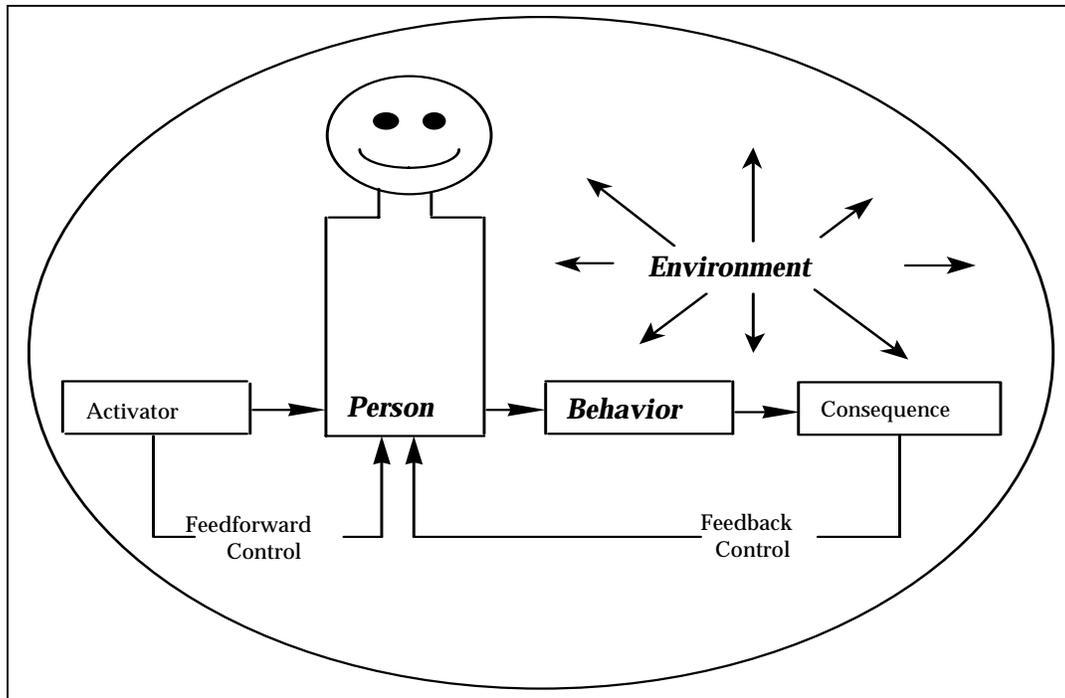
Summary. The Behavior Change Taxonomy (Geller, 1998a) predicts BB self-management may be one of the most effective behavior change techniques in situations where interpersonal observation and feedback is impossible. In fact, it is the only BB technique that can be applied to solitary workers. Self-management is straightforward, non-invasive, and practical in many situations. Moreover, it could include posting feedback, thereby soliciting social support. If self-management activities can be integrated with other job activities, safety practitioners will have an effective tool for improving safety-related behaviors that occur when there is little or no opportunity for interpersonal observation and feedback.

Current BB safety programs do not lend themselves to solitary workers. Since many workers in mining operations have little supervision, operate heavy machinery (e.g., crushers), or drive a vehicle (e.g., loaders or haulage trucks) as part of their job duties, it is crucial to focus research on developing cost-effective BB safety self-management techniques.

Feedforward versus Feedback

Information about individual performance can be given before or after behavior(s) targeted for improvement. Kreitner (1981/1982) referred to antecedent behavioral information as "feedforward," and information following behavior as "feedback." Additionally, Ford (1980) identified these two dimensions of feedback as immediate feedback (i.e., occurring after performance) and delayed feedback (i.e., delivered after some time interval following performance). However, Kreitner did not address the issue of the relative impact of these

alternative approaches. Figure 1, shown below, displays a comparison of feedforward versus feedback.



**Figure 1. A Comparison of Feedforward vs. Feedback
(Adapted from Kreitner, 1981/82).**

Since the early identification of presenting behavioral information as feedforward or feedback within the activator-behavior-consequence (ABC) paradigm of applied behavior analysis (Kreitner, 1981/1982), the author could find no published research that compared these approaches in the same study. In fact, the term “feedforward” is rarely used when referring to behavior-improvement interventions. Instead, the term “feedback” is used for both applications. Actually, some leaders in the field of organizational behavior management refer to feedback as only a behavioral antecedent (Daniels, 1989, 2000), whereas others discuss feedback as only a behavioral consequence (Geller, 1996, 2001b; Krause, Hidley, & Hodson, 1996; McSween, 1995).

Recently, Geller (1999, 2001a) proposed that the objective of a behavioral intervention should determine whether behavior-focused information should precede or follow the targeted behavior(s). More specifically, if the aim is to give direction or instruction, behavioral information should be given before an opportunity to perform (as feedforward), but if motivation rather than direction is needed, feedback is called for. This simple intuitive theory explained why feedforward information was more effective than feedback in increasing the safe driving behaviors of teenagers taking driving lessons (DePasquale & Geller, 2001). Presumably, the teens needed more instruction than motivation.

In contrast, nonspecific global feedback regarding workers' safety performance was sufficient in improving safety-related behaviors beyond levels attained with specific behavioral feedback when a global social comparison score was added to group feedback graphs (Williams & Geller, 2000). The authors explained their unexpected finding by assuming the workers did not need instruction as to what specific behaviors are safe versus at risk. Rather, they only needed some added motivation to select the safe alternatives. Apparently, the public accountability provided by general comparisons with a similar work group provided effective motivational consequences.

The current research compared a feedforward with a feedback presentation of behavioral information within the framework of safety self-management (Geller & Clarke, 1999). A comprehensive review of the self-management literature revealed no prior manipulation of this independent variable. Self-recording of target behaviors is always discussed as a behavioral consequence. In other words, the self-manager records the occurrence or nonoccurrence of one or more target behaviors, and then reviews the self-recordings as feedback (Watson & Tharp, 1997).

While the literature does not provide an example of a comparison between feedforward and feedback interventions in industrial settings, a straightforward rationale does exist in determining which one may be most beneficial. Individuals with little or no experience in the activity may require feedforward. This feedback serves two primary purposes: a) provides information to the individual on their performance, and b) provides the individual with needed direction to improve. Individuals with vast prior experience, deemed ‘experts’, may require motivation. These individuals know how to perform the behavior correctly, yet may lack the needed motivation to do so on a regular basis (cf. Geller, 1999, 2001a).

Overview of Current Study

While there is a great deal of prior research suggesting a BB peer observation and feedback approach leads to increases in safety-related work behaviors and reduction in injury rates, less is known about using self-management techniques with safety-related work behaviors. More specifically, the existing body of literature does not address the relative impact of using self-management approaches with safety-related work behaviors. The impact of BB safety self-management techniques was systematically evaluated in the current research.

Also, there is no prior research comparing the effectiveness of a feedforward or feedback presentation of behavioral information. While prior research studies have provided evidence that both are effective means of producing beneficial behavior change, the two have never been directly compared. The current research systematically compared the relative impact of a feedforward *versus* a feedback presentation of behavioral information within the framework of safety self-management.

Response generalization is a beneficial side effect in which the independent variable(s) has an indirect effect on non-targeted dependent variables (cf. Geller, 2002; Ludwig, 2002).

Interventions that produce beneficial response generalization are desirable because they are generally more cost-effective and less time consuming (i.e., less behaviors are targeted). The current research investigated response generalization (Stokes & Bear, 1977), in which distinctions were made between target and non-target safety behaviors.

Hypotheses

Hypothesis 1: Across all targeted dependent variables (i.e., safety-related work behaviors), participants in both the Feedforward and Feedback groups will have significantly higher mean percent safe scores during the Intervention phase, compared to their respective mean Baseline levels.

Hypothesis 2: Across all targeted dependent variables (i.e., safety-related work behaviors), participants in the both the Feedback and Feedforward groups will have significantly lower mean percent safe scores during the Withdrawal phase, compared to their respective Intervention levels.

Hypothesis 3: Across all non-targeted dependent variables (i.e., safety-related work behaviors), participants in both the Feedforward and Feedback groups will have significantly higher mean percent safe scores during the Intervention phase, compared to their respective Baseline levels (i.e., response generalization).

METHOD

Participants and Setting

Albert Moore, Industrial Hygienist for Environmental, Health and Safety Services at Virginia Polytechnic Institute and State University, contacted the Center for Applied Behavior Systems for assistance in increasing the use of personal protective equipment (namely hearing protection) at the Virginia Tech Quarry. The Virginia Tech Quarry, owned and operated by

Virginia Tech, is an above-ground stone quarry located in Blacksburg, VA. The Virginia Quarry is the only stone mine that services Virginia Tech with its unique gray and black stone, also called “Hokie Stone,” that has come to symbolize many of the campus building facades. While the raw stone is excavated much like at any other stone quarry (through the use of blasting and heavy equipment), the final product must be tailored to specific sizes, thus all the stones are hand chiseled.

The production process for this stone aggregate is as follows: a) the raw material is blasted from the side of the mountain in the quarry pit, b) this raw material is transported to the ‘drilling’ area where it is drilled into more manageable pieces, c) the drilled material is then transported to the ‘breaking room’ where it is broken down (into 10-45 lb square pieces) by a hydraulic crusher, d) the material is then transported to the ‘cutting room’ where it is hand chiseled to specific measurements, and e) the final product is placed on loading bins and wrapped for transport.



Worker’s from the VT Quarry ($n=15$), all of whom agreed to participate and signed a consent form (see Appendix A), were matched to one of two groups based on their Baseline safety performance across each target behavior and randomly assigned to one of two conditions: a) *Feedback*--self-recording of actual safety-related work behaviors (safe versus at-risk) after completing their shift at the end of the day and b) *Feedforward*--self-recording intentions to

engage in specific safety-related work behaviors before starting their shift for the day. The Virginia Tech Quarry is open from 7:30 a.m. to 3:30 p.m. All participants were Caucasian males. Three participants quit or were laid-off during the Baseline Phase (their data were removed from Baseline data) and two participants were hired four weeks prior to the start of the Intervention phase (their data were included).

General Procedures

Training. Participants in the Feedback and Feedforward groups received separate, two-hour training sessions on BB safety self-management techniques. The training included the following elements: a) a brief demographic questionnaire, b) the rationale for BB safety self-management, c) a presentation of the importance of consequence-focused self-observation (Feedback group) or activator-focused self-intentions (Feedforward group), d) training in using a self-monitoring form to record BB self-observations (Feedback group) or BB self-intentions (Feedforward group), e) group exercises to verify understanding on how to use a BB self-monitoring form, f) a brief video outlining the safety risks in mining operations, and g) a brief quiz to assess understanding of key points in the training session (i.e., a manipulation check on the training presentation). Additionally, the author informed the Feedback group what the Feedforward group was doing, and vice versa. See Appendix B for an example of the training materials, including demographic questionnaire and the brief quiz given at the end of each session.

Self-monitoring. The Intervention phase (4 weeks) immediately followed training. In this phase miners self-recorded their safety-related work behaviors on the self-monitoring forms before the beginning of their shift (Feedforward) or after their shift was over for the day (Feedback). Participants in the Feedforward condition calculated their percent safe scores from

their antecedent intentions (i.e., commitment) to work safely, whereas participants in the Feedback condition calculated their percent safe score from their self-reports of actual safety-related work behaviors. The participants placed the self-monitoring forms into a locked box to which only the project manager had access. See Appendix C for a copy of the self-monitoring forms.

At the beginning of each work week during the Intervention phase, the participants (in both Feedback and Feedforward conditions) received individual feedback on their safety performance, as well as a memo regarding their earned reward. The information was displayed graphically (see Appendix D for an example of the participant feedback graph and memo). Each participant was able to visually inspect his safety-related work behaviors, as recorded by trained research assistants (RA), against his intended safety performance (as in the Feedforward condition) or his estimated safety performance (as in the Feedback condition). The project manager (the author) delivered this information to the miners at the beginning of each Intervention week, in sealed envelopes.

Consequently, the participants' safety-related work behaviors were obtained in two ways: a) self-monitoring forms completed by miners on their actual (Feedback) and intended (Feedforward) safety-related work behaviors, and b) daily obtrusive observations of safety-related work behaviors from RAs.

Research Assistant Procedures

Training. Each RA received extensive training on a) the identification of safe versus at-risk target and non-target safety behaviors (through modeling and role-playing), b) BB observation and data collection procedures, and c) the recording of behavioral observations on a critical behavior checklist (CBC). See Appendix E for an example of the CBC used in this

research. Further, each RA had to obtain 80% agreement across all target and non-target behaviors, compared to an already reliable observer, on three consecutive observations sessions before the data were used in the current research. Weekly meetings were held to discuss any problems with data collection and observation procedures. The RAs were blind as to the group assignment of the miners.

Data collection and observation. First, the RAs drove to the Virginia Tech Quarry (about 10 minutes from campus) and upon arrival they signed in at the front office. Second, the RAs decided which observer would be primary or reliability (if two observers were present). Third, the RAs recorded the date and their RA data collection number. Fourth, the RAs made behavioral observations on participants safety-related work behaviors, only communicating with each other (if two observers are present) to identify which participant they would observe. Once the participant to be observed was identified, the RAs identified the participant by code, by comparing a picture of each miner along with a respective code (on a code sheet). Additionally, the RAs were given a Cutting Room layout sheet that displayed each participant's assigned work area and corresponding code. See Appendix E for the Cutting Room layout.

A participant's code corresponded to the participant's first two letters of the city in which he was born, the first two letters of his mothers' maiden name, and the month in which he was born (always two digits). Once the RAs identified the participant's code, they recorded the setting in which the behavioral observation was to take place. There were four possible settings: a) Drilling Area, b) Outside (anywhere outside of a building, excluding the drilling area), c) Breaking Room, and d) Cutting Room. These areas are visually displayed in Appendix F. Last, the RA made behavioral observations (marking safe or at-risk) on the identified participant's safety-related work behaviors. Observation sessions lasted from 30 min to 120 min, depending

on how many participants were present, the weather, and the participant's work environment.

The Withdrawal phase (four weeks) immediately followed the Intervention phase (four weeks), during which the participants no longer completed self-monitoring forms. During Withdrawal, both targeted and non-targeted safety behaviors continued to be observed and recorded by the RAs.

Focus group/post-intervention questionnaire. Following the termination of the Withdrawal phase, a focus group was held with all participants. The author asked the miners several questions, including: a) how the study could be improved, b) what they liked about the study, and c) what they disliked about the study. Additionally, a brief questionnaire was given to assess the social validity of the intervention and glean information from those who were quiet during the focus group. The post-intervention survey and focus group questionnaire are provided in Appendix G.

Dependent Variables

During the Intervention phase three PPE behaviors, including ear plugs, dust mask, and safety glasses were specifically targeted. These were PPE behaviors specifically reported by Albert Moore as needing improvement. The participants, in both conditions, self-observed and completed self-monitoring forms on these three target behaviors during the Intervention phase. Several other PPE behaviors (i.e., hard hat, steel-toe boots, and leather gloves) were observed and recorded by the RAs as a measure of response generalization.

Additionally, two non-PPE behaviors were observed and recorded by the RAs in order to assess generalization effects outside the response class of PPE behaviors. These other non-target behaviors were knee position during lifts and body position during lifts. The miners were

unaware the RAs were observing and recording these non-target safety behaviors. Listed below are all the dependent variables (target and non-target) observed in the current research.

Target Behaviors

Dust mask -- These must be placed securely around face with the strap on the back on the neck.

Hearing (earplugs) -- Hearing protection must be placed securely in each ear canal.

Safety Glasses -- These must be worn on face with the bridge on top of the nose and legs around ears. All glasses must have side shields as well as front lenses.

Non-Target Behaviors

Steel-Toe Boots -- Boots with steel toes must be worn on the feet and securely tied.

Hard Hat -- Hard hat must be facing forward and placed securely on top of the head

Leather Gloves -- Gloves must be worn securely on both hands.

Knee Position During Lifts -- When lifting loads, the employee should use legs and keep back straight. Legs should be bent so the thighs are parallel to the ground.

Body Positioning During Lifts -- Torso and legs should be facing the object the employee is attempting to lift. The torso should not twist, relative to the individual's thighs, at any point in the lift.

The percent safe scores for each behavior served as dependent measures. Each week, percent safe scores were calculated for each specific target and non-target behavior and means were calculated for the Feedforward and Feedback conditions. Individual performance was also tracked, as well as performance across settings. The formula for calculating these percentages is:

$$\% \text{ Safe Score} = \frac{\text{Total \# of Safe Observations}}{\text{Total \# of Safe Observations} + \text{At-Risk Observations}} \times 100\%$$

Participation. This naturally occurring variable was measured as the frequency of completed self-monitoring forms received. Employees were instructed to make one self-observation per day. Participation was measured as an overall percentage score (number of checklists received/number of possible work days). To motivate participation, the project manager paid each participant \$1.00 for every self-monitoring form completed and returned. Additionally, a cash raffle was held at the conclusion of the Intervention phase. Two winners were selected, one from each group, from all the completed self-monitoring forms. Each winner received a \$50.00 cash prize.

Experimental Design

This quasi-experimental field study used an interrupted A (Baseline) B (Intervention) A' (Withdrawal) time-series design, as depicted in Figure 2. Baseline observations by RAs were

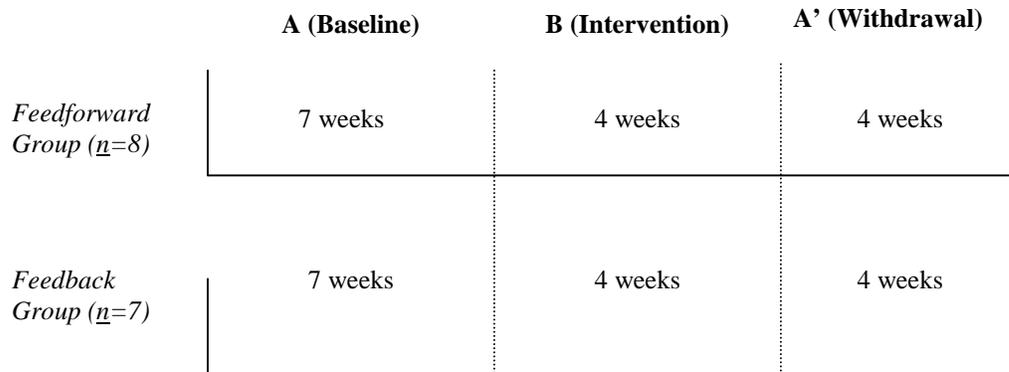


Figure 2. Time-Series Design for Current Research

conducted for 7 weeks. Because of the winter break, and the unavailability of RAs to collect data, the last two weeks of Baseline observations were suspended until the start of the Spring 2002 semester. This interruption was actually beneficial because it gave two new employees time to be properly trained. If Baseline observations had continued without this interruption, we could not have allowed these participants to be included in the current study because the

Intervention phase would have started before their employment and we would have had no Baseline observations for these employees.

As such, we only obtained a two-week Baseline on these miners. Following Baseline, participants in the Feedforward ($n=8$) and Feedback ($n=7$) groups completed self-monitoring forms and received individual feedback on their targeted safety behaviors for four consecutive weeks. At the conclusion of the Intervention phase, the participants' self-monitoring forms were removed and the RAs continued to make behavioral observations on both target and non-target safety behaviors for four consecutive weeks.

Because of the small sample size, it was possible that random assignment of subjects to the two different intervention conditions could result in two groups with vastly different Baseline data. To limit this possibility, the subjects were matched, according to their baseline safety performance for each of the three target behaviors.

Using frequency distribution control (Christensen, 1991), a matching technique that matches groups by equating the overall distribution on chosen variable(s), participants were placed in one of the two intervention conditions based on their Baseline mean percent safe score for each target behavior (i.e., dust masks, safety glasses, and ear plugs).

This process entailed placing miners into one of the two groups by visual inspection of their Baseline mean percent safe scores. Then, analyses were conducted to ascertain any significant differences. If differences were found, the process was continued by altering the composition of each group (i.e., switching miners to different groups) based on the results of the analyses. This process was continued until the analyses revealed no significant differences between each groups Baseline mean percent safe scores for each target behavior. In other words,

the miners were placed into one of the two intervention groups based on their mean percent safe scores for each target behavior.

The two groups were then randomly assigned to one of the treatment conditions (Feedforward vs. Feedback) by a coin toss. Each intervention group consisted of participants whose mean safety performance, across the three target behaviors, was similar to that of the other group. That is, a 2 Group (Feedforward, Feedback) X 2 Behavior (Safe, At-Risk) Chi-Square for each target behavior, indicated the percentage of safe behaviors during Baseline was not dependent on the group assignment.

General Data Analysis Procedures

Inter-observer agreement. In order to account for the possibility of a disproportionate number of safe vs. at-risk behaviors, two reliability formulas were used when comparing the RAs observations, as shown below:

$$\text{Percent Agreement for At-Risk Observations} = \frac{\text{At-Risk Agreements}}{\text{At-Risk Agreements} + \text{At-Risk Disagreements}} \times 100\%$$

$$\text{Percent Agreement for Safe Observations} = \frac{\text{Safe Agreements}}{\text{Safe Agreements} + \text{Safe Disagreements}} \times 100\%$$

Evaluation of interventions. Interventions were evaluated with visual inspection of time-series behaviors and with inferential statistical techniques, specifically analysis of variance (ANOVA) and Chi-Square. A 2 Group (Feedforward, Feedback) X 3 Phase (Baseline, Intervention, Withdrawal) X 4 Week (Week 1, Week 2, Week 3, Week 4) ANOVA was used to test all hypotheses. A mean percent safe score, using the percent safe score formula described above, was obtained for both target and non-target behaviors across all phases (i.e., 45% safe target behaviors during Baseline, 50% safe non-target behaviors during Baseline). The first 3

weeks of Baseline were cut from this analysis to allow for equivalent repeated measures (i.e., weeks) within each of the three phases. Although the data violate one assumption for using an ANOVA, namely equality of variance (the dependent variables are measured as a percentage and thus have restricted range), this test was performed to assess for interaction effects.

Chi-Square analyses were also used to test for significant differences between each target and non-target behavior across phase and group. Simple effects were tested with chi-square because of the dichotomous nature of the data (i.e., all-or-none classification of behaviors as safe or at-risk) and restricted range of the dependent variables.

Additional analyses were also performed. A 2 Group (Feedforward, Feedback) X 2 Observer (RA, self-monitoring) x 4 Week (Week 1, Week 2, Week 3, Week 4) ANOVA was used to assess main and interaction effects between the participants' self-monitoring forms and the RA's observations. From the RA's observation and the participant self-monitoring forms, a mean percent safe score was obtained for each participant, across the target behaviors each week. Mean percent safe scores for each participant's self-monitoring forms were obtained by aggregating their self-observed or self-intended safety scores, across target behaviors each week.

A Pearson Product Correlation was used to assess the correlation between the participant's self-monitoring data and the RA's observation data, across the three target behaviors. Once again, a mean percent safe score, across all target behaviors, was obtained for both the participants' self-monitoring forms and the RA's observation data using the percent safe score formula (described above) and by aggregating the participants self-monitoring data each week. Weekly comparisons were not made (i.e., dropped from that weeks analysis) on a participant unless he completed at least two self-monitoring forms, or RA(s) observed the participant for at least two observation sessions (i.e., two days that week). The author viewed

this as a liberal inclusion criteria (i.e., 40% of the work week) for estimating each participant's self-observed and actual safety performance, across the three target behaviors, for that week.

RESULTS

Interobserver Agreement

Reliability estimates were collected on 38 of the 68 observation sessions. Interobserver agreement percentages were calculated by dividing the total number of observations agreed upon by two data collectors for a given behavioral category (i.e., safe or at-risk) by the total number of agreements and disagreements, and multiplying by 100. The overall reliability estimates were calculated by averaging the agreement percentages for the 38 days on which two observers completed CBCs.

Baseline. Reliability estimates were collected on 19 of 33 days during the Baseline phase. A total of 1,699 behavioral reliability observations were made, or 49.9% of the total number of behavioral observations during Baseline. The overall reliability for observing safe behaviors in Baseline was: safety glasses (99.5%, $n=215$), ear plugs (96.7%, $n=80$), hard hat (0%, $n=0$), boots (100%, $n=262$), gloves (100%, $n=231$), dust mask (100%, $n=5$), knee position during lifts (93.3%, $n=15$), and body position during lifts (94.7%, $n=19$).

The overall interobserver reliability for at-risk observations in Baseline was: safety glasses (100%, $n=47$), ear plugs (100%, $n=196$), hard hat (100%, $n=269$), boots (96.3%, $n=7$), gloves (100%, $n=41$), dust mask (95.7%, $n=261$), knee position during lifts (96.6%, $n=29$), and body position during lifts (95.5%, $n=22$). Table 1 displays the reliability estimates for safe and at-risk behaviors during the Baseline phase.

<Insert Table 1 About Here>

Intervention. Reliability estimates were collected on 10 of 18 days during the Intervention phase. A total of 1,221 behavioral reliability observations were made, or 35.8% of the total number of behavioral observations during Intervention had reliably observations. The overall reliability for observations of safe behaviors in Intervention was: safety glasses (96.3%, $n=162$), ear plugs (95%, $n=80$), hard hat (0%, $n=0$), boots (94.7%, $n=189$), gloves (92.1%, $n=165$), dust mask (91.6%, $n=36$), knee position during lifts (92.9%, $n=28$), and body position during lifts (93%, $n=43$).

The overall reliability for at-risk observations in Intervention was: safety glasses (96.5%, $n=18$), ear plugs (96.8%, $n=96$), hard hat (100%, $n=188$), boots (0%, $n=0$), gloves (93.8%, $n=16$), dust mask (100%, $N=155$), knee position during lifts (91.7%, $n=24$), and body position during lifts (95.2%, $n=21$). Table 2 displays the reliability estimates for safe and at-risk behaviors during the Intervention phase.

<Insert Table 2 About Here>

Withdrawal. Reliability estimates were collected on 7 of 17 days during the Withdrawal phase. A total of 1,303 behavioral reliability observations were made, or 34.3% of the total number of behavioral observations during Withdrawal had reliability observations. The overall reliability of safe observations in Withdrawal was: safety glasses (100%, $n=151$), ear plugs (85.7%, $n=57$), hard hat (0%, $n=0$), boots (100%, $n=217$), gloves (100%, $n=189$), dust mask (90%, $n=10$), knee position during lifts (83.3%, $n=37$), and body position during lifts (94.7%, $n=53$).

The overall reliability of at-risk observations in Withdrawal was: safety glasses (100%, $n=43$), ear plugs (94.8%, $n=96$), hard hat (100%, $n=212$), boots (0%, $n=0$), gloves (88.5%, $n=26$), dust mask (100%, $n=132$), knee position during lifts (89.6%, $n=48$), and body position

during lifts (87.5%, $n=32$). Table 3 displays the reliability estimates for safe and at-risk behaviors during the Withdrawal phase.

<Insert Table 3 About Here>

Matching of Participants to Groups

Using frequency distribution control, participants were placed in one of the two Intervention conditions (Feedforward or Feedback) based on their mean baseline safety performance for the three target behaviors (i.e., dust mask, safety glasses, and ear plugs). As a result, each intervention group consisted of miners whose mean percent safe scores, across the three target behaviors, were similar. A 2 Group (Feedforward, Feedback) X 2 Behavior (Safe, At-Risk) Chi-Square was calculated on each target behavior.

<Insert Table 4 About Here>

Table 4 displays the mean percent safe scores and Chi-Square statistic for each target behavior, across both groups, during Baseline. Mean percent safe scores for each target behavior during Baseline were as follows: a) safety glasses (Feedforward=77.6%, Feedback=83.6%; $X^2_{(1)}=3.04$, $p>.10$), b) ear plugs (Feedforward=24.5%, Feedback=29.3%; $X^2_{(1)}=1.58$, $p>.10$), and c) dust mask (Feedforward=.42%, Feedback=.34%; $X^2_{(1)}=.023$, $p>.10$). Thus, there were no significant differences between the groups mean safety scores for the three target behaviors.

<Insert Table 5 About Here>

Table 5 displays the mean percent safe scores and Chi-Square statistic for each non-target behavior, across both groups, during Baseline. Mean percent safe scores for each non-target behavior during Baseline were as follows: a) hard hat (Feedforward=0%, Feedback=0%; no difference), b) boots (Feedforward=100%, Feedback=99.7%; $X^2_{(1)}=.588$, $p>.10$), c) gloves (Feedforward=89.5%, Feedback=84.7%; $X^2_{(1)}=2.64$, $p>.10$), knee position during lifts

(Feedforward=33.8%, Feedback=31.4%; $X^2_{(1)}=.105$, and e) body position during lifts (Feedforward=51%, Feedback=52.9%; $X^2_{(1)}=.086$). Thus, there were no significant differences between the groups' mean safety scores for the non-target behaviors. While participants were not matched on any of the non-target behaviors, there were no significant differences for any of the non-target safety behaviors. This allows for informative between-group comparisons during the Intervention phase for the non-targeted behaviors.

Training Materials

Demographic characteristics. During training, participants in each group were given a brief demographic questionnaire. An ANOVA was performed on all the demographic characteristics, excluding gender and ethnicity (both are categorical variables). No further analyses were performed on gender and ethnicity because both groups had identical characteristics. The demographic characteristics for each group include: a) Mean age (Feedforward=33.5 years, Feedback=33.3 years; $F=.019$, $p>.10$), b) Gender/Ethnicity (Feedforward=100% Caucasian Males, Feedback=100% Caucasian males; no difference), c) Mean length of employment at the Virginia Tech Quarry (Feedforward=4.9 years, Feedback=5.4 years; $F=.035$, $p>.10$), d) Mean length of employment in mining operations (Feedforward=5.3 years, Feedback=7.4 years; $F=2.28$, $p>.10$), e) Mean number of safety incidents requiring time-off work in the last year (Feedforward=.5 incidents, Feedback=.4 incidents; $F=.043$, $p>.10$) and f) Mean number of safety incidents requiring time-off work in the last three years (Feedforward=1 incident, Feedback=1 incident; no difference). The results indicate no significant differences between any of the demographic variables. Yet, participants in the Feedback group had been working somewhat longer (on average) and were more experienced in

mining operations than participants in the Feedforward group. Table 6 displays the demographic characteristics for the participants in each group.

<Insert Table 6 About Here>

Manipulation check for training presentation. A brief, four question, pre-intervention quiz was given to each participant at the completion of the training session. The purpose of this quiz was to make sure each training session was similar, and to assess if the training presentation had adequately reviewed key intervention elements, including a) when to complete self-monitoring forms, b) how to set BB goals, c) reward/incentive instructions, and d) positive consequences associated with at-risk behaviors. Question 3 of the quiz served as a manipulation check for the group distinction (i.e., Feedforward vs. Feedback). All participants, from both groups, obtained 100% correct on this quiz. Table 7 displays the quiz questions and the correct answers obtained from every participant.

<Insert Table 7 About Here>

Dependent Measures

Self-management effectiveness. Based on 10,905 behavioral observations, BB self-management was effective in increasing mean percent safe scores over Baseline levels. In the Feedforward group the mean percent safe score across target behaviors rose from 34.8% at Baseline to 46.8% at Intervention and decreased to 40.4% at Withdrawal. Similarly, in the Feedback group the mean percent safe score across target behaviors rose from 38.2% at Baseline to 53.5% at Intervention and decreased to 43.9% at Withdrawal. A 2 Feedback Type (Feedforward, Feedback) X 3 Phase (Baseline, Intervention, Withdrawal) X 4 Week (Week 1, Week 2, Week 3, Week 4) ANOVA was calculated on the mean percent safe score across the

three target behaviors. The results for the ANOVA revealed only a significant effect for phase ($F=9.02$, $p<.01$). No other effects were statistically significant (all $p's>.05$).

The first hypothesis stated *all* targeted dependent variables in both the Feedforward and Feedback conditions will result in significantly higher mean percent safe scores compared to their respective mean Baseline levels. A follow-up 2 Feedback Type (Feedforward, Feedback) X 2 Phase (Baseline, Intervention) X 4 Week (Week 1, Week 2, Week 3, Week 4) ANOVA found a significant increase in mean percent safe scores across the three target behaviors between the Baseline and Intervention phase ($F=16.63$, $p<.01$). The main effect for phase was statistically significant and Hypothesis 1 was supported. The second hypothesis that *all* targeted dependent variables (i.e., safety-related work behaviors) for participants in both groups (i.e., Feedforward and Feedback Conditions) will have significantly lower mean percent safe scores in Withdrawal compared to their respective Intervention levels. A follow-up 2 Feedback Type (Feedforward, Feedback) X 2 Phase (Intervention, Baseline) X 4 Week (Week 1, Week 2, Week 3, Week 4) ANOVA found a significant decrease in mean percent safe scores across target behaviors between Intervention and Withdrawal phases ($F=7.93$, $p<.01$). The main effect for phase was statistically significant and Hypothesis 2 was supported

<Insert Figure 3 About Here>

The mean percent safe score across non-target behaviors in the Feedforward group rose from 56.6% at Baseline to 64.9% at Intervention and decreased to 58.9% at Withdrawal. Mean percent safe score across non-target behaviors in the Feedback group rose from 57.6% at Baseline to 62.9% at Intervention and decreased to 61% at Withdrawal. A 2 Feedback Type (Feedforward, Feedback) X 3 Phase (Baseline, Intervention, Withdrawal) X 4 Week (Week 1, Week 2, Week 3, Week 4) ANOVA was calculated on the mean percent safe score for non-target

behaviors. The results for the ANOVA revealed a significant effect for phase ($F=11.5$, $p<.01$). No other effects were statistically significant (all $p>.05$). The third hypothesis stated that all non-targeted dependent variables in both the Feedforward and Feedback Conditions would result in significantly higher mean percent safe scores during Intervention, compared to their respective Baseline levels. Follow-up 2 Feedback Type (Feedforward, Feedback) X 2 Phase (Baseline, Intervention) X 4 Week (Week 1, Week 2, Week 3, Week 4) ANOVA found a significant increase in mean percent safe scores across non-target behaviors between Baseline and Intervention phases ($F=23.34$, $p<.01$). The main effect for phase was statistically significant for non-target behaviors across groups. Figure 4 displays the week-by-week mean percent safety scores for non-target behaviors across groups.

<Insert Figure 4 About Here>

Baseline versus Intervention (target behaviors). Based on 1,593 behavioral observations during Baseline and 1,482 behavioral observations during Intervention, both the Feedforward and Feedback self-management interventions were effective in increasing percent safe scores over a Baseline condition. Overall, mean percent scores in the Feedback group for use of safety glasses rose from 83.6% ($n=308$) at Baseline to 95.4% ($n=277$) at Intervention, use of ear plugs rose from 29.3% ($n=281$) at Baseline to 53.5% ($n=243$) at Intervention, and dust mask usage rose from .34% ($n=293$) at Baseline to 8.1% ($n=260$) at Intervention. Overall, mean percent scores in the Feedforward group for use of safety glasses rose from 77.6% ($n=244$) at Baseline to 85.2% ($n=237$) at Intervention, use of ear plugs rose from 24.5% ($n=237$) at Baseline to 47.3% ($n=232$) at Intervention, and dust mask usage rose from .42% ($n=230$) at Baseline to 5.1% ($n=233$) at Intervention. Figure 5 displays the week by week mean percent safe scores, for each target behavior, for the Feedforward and Feedback groups across all phases.

<Insert Figure 5 About Here>

A 2 Phase (Baseline, Intervention) X 2 Behavior (Safe, At-Risk) Chi-Square statistic showed a significant increase in mean safety scores for each target behavior. In the Feedforward group, the Chi-Square statistic for safety glasses ($X^2_{(1)}=4.52$, $p<.05$), ear plugs ($X^2_{(1)}=26.75$, $p<.01$), and dust mask ($X^2_{(1)}=9.62$, $p<.01$) showed a significant difference between Baseline to Intervention phases. Similarly, in the Feedback group, the Chi-Square statistic for safety glasses ($X^2_{(1)}=19.72$, $p<.05$), ear plugs ($X^2_{(1)}=33.12$, $p<.01$), and dust mask ($X^2_{(1)}=21.67$, $p<.01$) showed a significant difference between the Baseline and Intervention phases. Thus, Hypothesis 1 was supported for each target behavior. Table 8 displays the mean percent safe scores and Chi-Square statistic, for each target behavior separately, for both the Feedforward and Feedback groups during the Baseline and Intervention phases.

<Insert Table 8 About Here>

Intervention versus Withdrawal (target behaviors). Based on 1,482 behavioral observations during Intervention and 1,893 behavioral observations during Withdrawal, both the Feedforward and Feedback self-management interventions displayed decreasing mean percent safe scores. Overall, mean percent scores in the Feedback group for use of safety glasses decreased from 95.4% ($\underline{n}=277$) at Intervention to 93.5% ($n=291$) at Withdrawal, use of ear plugs decreased from 53.5% ($\underline{n}=243$) at Intervention to 37.3% ($\underline{n}=283$) at Withdrawal, and dust mask usage decreased from 8.1% ($\underline{n}=260$) at Intervention to 1.8% ($\underline{n}=299$) at Withdrawal.

Overall, mean percent safe scores in the Feedforward group for use of safety glasses decreased from 85.2% ($\underline{n}=237$) at Intervention to 84.1% ($\underline{n}=329$) at Withdrawal, use of ear plugs decreased from 47.3% ($\underline{n}=232$) at Intervention to 34.2% ($\underline{n}=351$) at Withdrawal, and dust mask usage decreased 5.1% ($\underline{n}=233$) at Intervention to 1.0% ($\underline{n}=340$) at Withdrawal. Figure 5 displays

the week by week mean percent safe scores, for each target behavior, for both the Feedforward and Feedback groups across all phases.

A 2 Phase (Intervention, Withdrawal) X 2 Behavior (Safe, At-Risk) Chi-Square statistic showed significant differences in mean percent safe scores for each target behavior, except use of safety glasses. In the Feedforward group, use of ear plugs ($X^2_{(1)}=9.65$, $p<.01$) and dust mask usage ($X^2_{(1)}=4.81$, $p<.05$) showed a significant decrease between Intervention and Withdrawal phases. Safety glass usage showed no significant difference ($p>.10$). In the Feedback group, use of ear plugs ($X^2(1)=11.05$, $p<.01$) and dust mask usage ($X^2(1)=16.16$, $p<.01$) showed a significant difference between Intervention and Withdrawal phases. Safety glass usage showed no significant difference ($p>.10$). The second hypothesis stated that all targeted dependent variables (i.e., safety-related work behaviors) for participants in both groups (i.e., Feedforward and Feedback Conditions) will have significantly lower mean percent safe scores in Withdrawal compared to their respective Intervention levels. Overall, the main effect for phase was statistically significant for two of the three target behaviors. Thus, Hypothesis 2 was moderately supported. Table 9 displays the mean percent safe scores and the Chi-Square statistic, per each target behavior, for both the Feedforward and Feedback groups during the Intervention versus Withdrawal phases.

<Insert Table 9 About Here>

Response generalization (non-target behaviors). Based on 1,927 behavioral observations during Baseline and 1,887 behavioral observations during Intervention, both the Feedforward and Feedback groups were effective in increasing mean percent safe scores for non-target behaviors over a Baseline condition. Overall, mean percent scores in the Feedback group for use of hard hat remained unchanged from 0% ($n=305$) at Baseline to 0% ($n=259$) at

Intervention, use of boots rose slightly from 99.7% ($n=293$) at Baseline to 100% ($n=270$) at Intervention, use of gloves rose from 84.7% ($n=281$) at Baseline to 91.2% ($n=251$) at Intervention, safe knee position during lifts rose from 31.4% ($n=86$) at Baseline to 64.8% ($n=128$) at Intervention, and safe body position during lifts rose from 52.9% ($n=87$) at Baseline to 71.2% ($n=125$) at Intervention.

Overall, mean percent scores in the Feedforward group for hard hat usage remained unchanged from 0% ($n=226$) at Baseline to 0% ($n=277$) at Intervention, use of boots remained unchanged from 100% ($n=238$) at Baseline to 100% ($n=243$) at Intervention, use of gloves rose from 89.5% ($n=250$) at Baseline to 92.4% ($n=260$) at Intervention, safe knee position during lifts rose from 33.8% ($n=88$) at Baseline to 68.3% ($n=35$) at Intervention, and safe body position during lifts rose from 51% ($N=81$) at Baseline to 69.4% ($n=39$) at Intervention. Figures 6 and 7 display week-by-week mean percent safe scores for each non-target PPE behavior and non-target lifting behavior, respectively.

<Insert Figure 6 About Here>

<Insert Figure 7 About Here>

A 2 Phase (Intervention, Withdrawal) X 2 Behavior (Safe, At-Risk) Chi-Square statistic showed significant differences in mean percent safe scores for three of five non-target behaviors for the Feedback group and two of five behaviors for the Feedforward group. Specifically, for the Feedback group, use of gloves ($X^2_{(1)}=5.34$, $p<.05$), safe knee position during lifts ($X^2_{(1)}=21.67$, $p<.01$), and safe body position during lifts ($X^2_{(1)}=23.04$, $p<.01$) showed a significant increase between Baseline and Intervention phases. The two other non-target behaviors did not change significantly (all p 's>.10).

For the Feedforward group, safe knee position during lifts ($X^2_{(1)}=23.15$, $p<.01$) and safe body position during lifts ($X^2_{(1)}=7.3$, $p<.01$) increased significantly from Baseline to Intervention. The three other non-target behaviors did not change significantly (all $p's>.10$). Consequently, two non-target behaviors in both groups, safe knee position during lifts and safe body position during lifts, and use of gloves in the Feedback group showed significant increases from Baseline to Intervention. As such, Hypothesis 2 was moderately supported. Table 10 displays the mean percent safe scores per each non-target behavior, for both the Feedforward and Feedback groups during Baseline versus Intervention.

<Insert Table 10 About Here>

Participation

Participation was evaluated by calculating the frequency (i.e., number) of self-monitoring forms completed and returned, divided by the total number of possible work days (20 days) during Intervention. Participants in the Feedforward ($n=8$) group completed 83.8% of the possible self-monitoring forms (134 of 160 possible self-monitoring forms). Participants in the Feedback ($n=7$) group completed 80.7% of the possible self-monitoring forms (113 of 140 possible self-monitoring forms). Table 11 displays the participation percentage for each miner in both the Feedforward and Feedback groups.

<Insert Table 11 About Here>

Post-Intervention Questionnaire

Immediately following Withdrawal, participants were asked to complete a brief post-intervention questionnaire. The questionnaire asked: a) When did you complete your checklist?, b) Did you discuss your feedback with coworkers?, c) How often did you discuss your feedback with coworkers?, d) Did you change your safety behaviors because you knew people were

observing you?, e) I believe this safety program was very beneficial for my safety?, and f) Did you find the feedback on your safety behaviors useful?

<Insert Table 12 About Here>

All fifteen participants completed the post-intervention survey. Table 12 depicts each participant's response on the post-intervention survey. For the Feedback group, 100% of the participants reported completing their self-monitoring forms at the appropriate time (after their shift for the day), 85.7% of the participants (6 of 7) discussed their individual feedback with coworkers, and of those who did discuss their feedback, 83.3% (5 of 6) did so every week. None of the participants indicated they altered their safety performance because they were being observed. A few miners, 28.6% (2 of 7), believed the safety program was beneficial, 42.9% (3 of 7) were neutral, and 28.6% believed the safety program was not beneficial. Additionally, 71.4% (5 of 7) of the participants indicated the feedback they received on their safety performance was useful, while 28.6% (2 of 7) did not find the feedback useful.

For the Feedforward group, 100% of the participants reported completing their self-monitoring forms at the appropriate time (before their shift for the day), 50% of the participants (4 of 8) discussed their individual feedback with coworkers, and of those who did discuss their feedback, 75% (3 of 4) did so every week. None of the participants indicated they altered their safety performance because they were being observed. A Majority of these participants, 63.5% (5 of 8), believed the safety program was beneficial and 37.5% (3 of 8) were neutral. Additionally, 100% (8 of 8) of the participants indicated the feedback they received on their safety performance was useful. Thus, the social validity results were slightly more positive for the Feedforward group than the Feedback group.

Focus Group Responses

A focus group was held at the conclusion of the Withdrawal phase. The aim of this discussion was to allow participants a chance to verbalize their thoughts and opinions regarding the safety process, and to ascertain what aspects of the process they liked and disliked. Participants indicated they enjoyed: a) people coming to observe their behaviors, because it broke the monotony of work and made them feel important because someone cared about their safety, b) money for completing the checklists, and c) actually completing the checklists. Several participants indicated the self-monitoring forms were a constant reminder to behave safely.

The miners disliked the fact they were only observed for short periods of time. They believed the brief observation sessions led to inaccurate conclusions about their safety. Some workers reported completing their self-monitoring forms days in advance (knowing the project manager picked-up the self-monitoring forms at the end of the week). Suggested improvements for the current safety program included: a) longer observation sessions, and b) having observers come at times when they aren't on break. Yet, most of the participants agreed they would like to continue the safety program.

Exploratory Analyses

While no *a priori* hypotheses regarding comparisons between participant's self-observation data and the RA's observations of participants safety-related work behaviors were discussed, these distinctions are critically important topics within a BB self-management framework. Given that safety self-management will primarily be used with solitary workers and workers with little direct supervision, the accuracy of these self-observations is important.

A 2 Feedback Type (Feedforward, Feedback) X 2 Observer (Participant, RA) X 4 Intervention Week (Week 1, Week 2, Week 3, Week 4) ANOVA was conducted on the mean percent safe score across target behaviors. This 2 X 2 X 4 ANOVA showed only a main effect of week ($F=2.94$, $p<.05$). No other significant effects were revealed (all $p's>.05$). The effect of week was essentially due to the increasing trend in mean percent safe scores per each target behavior from Week 1 to Week 4 during Intervention.

Accuracy of self-monitoring. A two-tailed Pearson Product Correlation was calculated, each week of the Intervention phase, comparing participant's self-intentions (Feedforward) or self-observations (Feedback) with the RA's behavioral observations on their mean percent safe scores across target behaviors (e.g., participant ROLO05 self-observed 45% safe target behaviors in Week 1, and the RA's observed 50% safe target behaviors during Week 1). Overall, the mean percent safe score, across target behaviors and groups during Week 1 was 44.8% versus 53% for the RAs and the participants, respectively ($r=.760$, $p<.01$), 56.8% versus 60.6% ($r=.747$, $p<.01$) during Week 2, 55.4% versus 48.8% ($r=.652$, $p<.01$) during Week 3, and 46.4% versus 46.7% ($r=.792$, $p<.01$) during Week 4. Figure 8 displays the mean percent safe scores, across target behaviors and groups, for the RA's observations and participant's self-monitoring forms during Intervention. The data indicate the participant's self-observations were similar to the RA's observations.

<Insert Figure 8 About Here>

DISCUSSION

This quasi-experimental field study evaluated the effectiveness of a BB safety self-management approach to increase safety-related work behaviors in mining operations. Almost all prior BB safety research has targeted behaviors in work settings where employees can

systematically observe the safe versus at-risk behavior of their coworkers (e.g., DePasquale & Geller, 1999; Geller, 1996, 1998c; Geller, & Williams, 2001; Krause, Hidley, & Hodson, 1996; McSween, 1995; Petersen, 1989; Williams & Geller, 2000). However, employees who work in relative isolation or have little oversight, compared to traditional industrial workers, require a process by which they can systematically observe themselves.

The current field study attempted to answer the following empirical questions concerning the impact of a BB safety self-management: a) Is BB safety self-management effective in increasing safety-related work behaviors in mining operations?; and b) To what extent do safety-related work behaviors not specifically targeted by the BB safety self-management intervention procedure improvement (i.e., response generalization)?

Effectiveness of Self-Management

Similar to past self-management interventions (Baker & Kirschenbaum, 1983; Curry, 1993; Garvin *et al.*, 1992; Kavanagh & Sayer, 1996; Shiffman, 1984; Sobell & Sobell, 1995), BB safety self-management led to clear improvement in subsequent safety performance. Based on 10,905 behavioral observations, BB self-management was effective in increasing mean percent safe scores over baseline levels. In the Feedforward group, the mean percent safe score across three target behaviors rose from 34.8% at Baseline to 46.8% at Intervention and decreased to 40.4% at Withdrawal. Similarly, in the Feedback group, the mean percent safe score across three target behaviors rose from 38.2% at Baseline to 53.5% at Intervention and decreased to 43.9% at Withdrawal.

The introduction of the BB self-management intervention was clearly beneficial in improving safety performance for three target behaviors, relative to their respective baseline levels. These results support the main hypothesis, that both groups would increase their safety

performance in the BB self-management intervention phase, relative to baseline safety performance. In interpreting these results, two important considerations must be addressed.

First, the target behavior, dust mask, was rarely performed during baseline (.42% usage in the Feedforward groups and .34% usage in the Feedback group) and represents a floor effect. While miners did increase their use of dust mask during intervention (8.1% usage and 5.1% usage in the Feedback and Feedforward groups, respectively), these results are not that impressive because baseline levels were near zero.

Second, the target behavior, safety glasses, was performed quite often during baseline (77.6% use and 83.6% use in the Feedforward and Feedback groups, respectively). Yet, miners in both groups significantly improved their use of safety glasses during intervention (85.2% usage and 95.4% usage in the Feedforward and Feedback groups respectively). Taken together the results suggest BB self-management was effective in increasing safety performance in both low and high occurrence safety behaviors.

The results add to the already voluminous literature on the effectiveness of BB observational feedback (Van Houten, Nau, & Marini, 1980; Van Houten & Nau, 1983; Geller, 2001a; Williams & Geller, 2001) and goal setting (Latham & Locke, 1991; Neubert, 1998) to increase safety-related behaviors. However, none of the observations in the prior research studies were self-observations, and no prior research has systematically compared a feedforward versus a feedback presentation of BB information. The results suggest feedforward (self-intention) was just as effective as feedback (self-observed) in increasing specific safety-related work behaviors. This suggests a feedforward presentation is similar in effectiveness to a feedback presentation of behavioral information. In fact, it can be argued that feedforward may be more preferable than feedback based on the miner's opinions on the post-intervention

questionnaire (63.5% of miners in the Feedforward groups believed the BB self-management intervention was beneficial for their safety, as opposed to 28.6% in the Feedback group).

The hypothesis that both groups would significantly increase their performance of non-target behaviors, and show response generalization during BB self-management, was also supported. The introduction of the BB self-management intervention was clearly beneficial in improving safety performance for three of five non-target safety behaviors for the Feedback group (i.e., gloves, knee position during lifts, and body position during lifts) and two of five non-target safety behaviors for the Feedforward group (i.e., knee position during lifts and body position during lifts). While the results suggest the Feedback group was superior to the Feedforward group, the non-significant difference in glove usage can be attributed to differential baseline levels (89.5% and 84.7% glove usage during baseline for the Feedforward and Feedback groups, respectively).

The lack of a significant change in two other non-target behaviors is clear. Miner's use of boots during Baseline was near perfect (99.7% use for the Feedback group and 100% use for the Feedforward group). This represents a ceiling effect and is the reason for the lack of significant findings. The non-target behavior, hard hat use, represents the opposite extreme. This behavior was never performed during Baseline, or any other phase (0% usage for both Feedforward and Feedback groups) and represents a floor effect.

These results add to the growing body of literature on response generalization. Geller (2002a) proposed the amount of desirable versus undesirable generality is determined by the degree of self-persuasion facilitated by the intervention. Further, according to cognitive dissonance theory (Festinger, 1957) and the principle of consistency (Cialdini, 2001), self-directed behavior obligates a person to emit other behaviors related to the target behavior. Yet, if

an intervention is perceived as top-down, or controlling it can influence countercontrol (Skinner, 1953) and undesirable side effects.

While miners in the current study were instructed on which target behavior to self-monitor, they had the freedom to choose their own personal goals for their specific safety-related work behaviors, and they participated (i.e., completed self-monitoring forms) as often as they desired. Furthermore, the basic premise of self-management is self-direction and self-control. The miners' perceived choice and sense of control over the intervention may be one possible explanation for the beneficial side-effects (i.e., response generalization). It's likely the self-management process produced self-persuasion.

The exact definition of response generalization has been debated by many behavioral scientists in the field. While most agree response generalization (e.g., Daniels, 2001; Kazdin, 2001; Staddon, 2001) refers to a spread of effect from a target behavior to a similar non-target behavior. Controversy surrounds the definition of "similar" and whether the term "generalization" is appropriate for this beneficial side-effect of an intervention.

A thorough discussion of the response generalization debate is beyond the scope of this paper. See Austin and Wilson (2002), Geller (2002a), Houchins and Boyce (2002), and Ludwig (2002) for a more detailed description of each viewpoint. In any case, the results of the current study show a positive spread of intervention impact from target behaviors to non-target behaviors of the same response class (i.e., general safety behaviors). The intervention not only produced a spread of effect from target PPE behaviors to non-target PPE behaviors, but also to non-target lifting behaviors. While lifting and PPE behaviors appear to belong to different response-specific classes (i.e., PPE and lifting behaviors are clearly different in topography), they both are subsumed under the general conceptual class of safety (Ludwig, 2002).

The hypothesis that both groups would have significantly lower mean percent safe scores per each target behavior after the removal of the BB self-management intervention was supported. Participants in both groups displayed significant decreases in their mean percent safe scores for both dust mask and ear plug usage. Non-significant decreases were obtained with safety glass usage. It's possible more post-intervention RA observations of safety glass use would have shown a significant decline, given that safety glass use in the Feedback group reveals a downward trend over the last two-weeks of Withdrawal.

The return to near Baseline levels of performance after the self-management intervention was removed provides evidence the resultant behavior change during intervention was not due to training or the increased attention to safety. Rather, these results suggest the self-management intervention was responsible for the increase in target and non-target safety performance during intervention. However, this lack of maintenance does contradict a self-persuasion explanation (Aronson, 1999; Geller, 2002b).

However, these results should be viewed with reservation. Why didn't the program produce more behavior change? That is, why didn't miners perform the target behaviors at/or near 100% safe? One possible explanation was the lack of supervision (i.e., top-down control) at the Virginia Tech Quarry. The quarry foreman (on-site) was responsible for managing the miner's daily activities, and the quarry manager was responsible for production contracts and quotas, supply purchasing (safety equipment, haulage, tools, etc), Mine Safety and Health Administration (MSHA) compliance, and recruitment. While these individuals (foreman and quarry manager) were responsible for equipping the miners with the proper PPE and providing routine safety training, there was little in the way of consequences for the miner's lack of compliance with safety standards. If a miner was non-complaint with respect to PPE, such as not

wearing his safety glasses, there was no consequence (i.e., verbal reprimand, safety prompt, or penalty). Preference was given to production quotas over safety compliance.

The analysis of the accuracy of the participant's self-observations provided some interesting results. Miners overestimated their mean percent safe scores across target behaviors in Weeks 1 and 2, however in Week 3 they markedly underestimated their mean percent safe scores across target behaviors. Interestingly, in Week 4 their mean percent safe scores were most congruent with the RA's observations. This suggests the miners were using the individual feedback, which they received each week, to make their self-observations more realistic and consistent with those of the RA's.

More specifically, the discrepancy between the RA's observations and participants mean percent safe scores across target behaviors were reduced in Week 2, compared to the discrepancy in Week 1. Then, the miners actually underestimated their mean percent safe scores in Week 3, as if they were attempting to overcompensate based on their discrepancy in Week 2. Finally, in Week 4 their observations were most like those of the RAs.

There are at least two possible explanations for the observed fluctuations in the gap between the miners' and the RA's observations. Miners may have experienced cognitive dissonance because of their discrepancy between their self-observations and the RA's observations (Festinger, 1957). Also, miners may have altered their self-observations in order to be consistent with the RA's observations, as suggested by the principle of consistency (Cialdini, 2001).

The literature (Bernardin & Beatty, 1984; Harris & Schaubroeck, 1988) regarding self-observations or self-appraisals indicates individuals will overestimate their performance (i.e., provide an unduly positive rating). The results support this literature to a certain extent. That is,

they did overestimate at first, but when they found the author was providing objective feedback they changed. Perhaps, the accountability provided by the author altered their perceptions. Their perception of “looking good” or “doing the right thing” changed from “being safe” to limiting the discrepancy between the RA’s observations.

Limitations of Current Study

One limitation in the current study was the obtrusiveness of the data collection methods. Miners were aware the RAs were collecting data on their target behaviors and may have altered their performance accordingly. However, none of the participants admitted on the post-intervention questionnaire that they altered their behaviors because they knew they were being observed. And, even if such reactivity occurred, it was constant across all phases. If anything, the mean percent safe scores obtained during baseline may have been overly inflated, resulting in a more robust effect during intervention. Indeed, an effect of reactivity to being observed is likely to be most prominent at the beginning of such procedures (Cambell, 1957). People typically become accustomed to being observed, and with time show decreased reactivity to being observed.

A second limitation in the study was the ‘kitchen sink’ approach of the independent variable. No attempt was made to assess the differential effects of goal setting, objective feedback, and self-monitoring. As such, the current study attempted to find an impact of the overall intervention program without attempting to discern which intervention component(s) are necessary or sufficient (cf. Azrin, 1977). Moreover, goal-setting strategies were taught to miner’s during the training presentation, yet no attempt was made to hold miners accountable for their goal setting by completing a goal-setting checklist or to assess if these individuals were actually setting weekly goals (although miners in the Feedforward group were essentially setting

a daily commitment, which could be interpreted as a BB goal).

A third limitation in the study was the small sample size. The within-subject pool was very small for both Feedforward and Feedback groups ($n=8$ and 7, respectively), leaving limited power for statistical analysis. Further, matching the subjects to treatment groups, as opposed to random assignment, reduced statistical power.

A fourth limitation in the study was the quasi-experimental design. Because participants came from an intact group, the external validity of these results may be equivocal. This special group of mining employees are not involved in the most typical mining operations. The mine setting itself is probably not indicative of most above-ground stone aggregate mines, given the Virginia Tech Quarry services a major university with its unique "Hokie Stone." Similarly, the group consisted of 100% Caucasian males. While it can be argued the majority of employees in mining operations are predominantly male, the lack of any ethnic diversity severely limits the generalization of the results. In addition, since the miners worked together on a daily basis, diffusion of treatment was guaranteed. The author never concealed the group differences during the training presentations. In fact, he told the Feedforward group what the Feedback group was doing, and vice versa.

A fifth drawback of this study was the lack of an assessment procedure to determine if participants actually completed self-observations at the appropriate time. All the participants indicated they knew when to complete the self-monitoring form (as evidenced by the 100% accuracy on the brief training quiz), and all the participants indicated they did complete their self-monitoring forms at the correct time (as evidence by the 100% accuracy on the post-intervention survey). Yet, no attempt was made to assess if this was actually occurring. In fact, because the author picked-up all the completed self-monitoring forms from the lock-box at the

end of the week it was possible for miners to complete multiple self-monitoring forms each day. Indeed, some of the miners admitted to doing this when queried during the focus group. It would have been more appropriate to pick up the survey forms each day rather than weekly.

A sixth limitation in the current study is the practicality in implementing such a program in other industrial settings. Most industrial organizations expect 100% compliance with safety standards. Implementing a process similar to the current study would necessitate management allowing employees to set substandard goals (i.e., <100% safe). It's unlikely management would allow such a process to be implemented with company mandated or Organization of Safety and Health Administration (OSHA) safety and health standards. Yet, this process may be ideal for safety behaviors that aren't mandatory, but need improvement.

Finally, the short observation periods may not reflect the true safety performance at the Virginia Tech Quarry. Observation sessions lasted from 30 to 120 minutes. This equates to roughly 2 to 10 minutes ($\approx 2\%$ of their work day) of observation time per miner. Add to this the all-or-nothing nature of the RAs observations, and misrepresentation is likely. If a miner did not use his safety glasses during the brief time the RA(s) observed him, he would be marked 100% at-risk, even if he wore them the rest of the day. While this sampling problem appears to be huge, the mean percent safe scores across target behaviors from miners self-monitoring forms and the RAs' observations never differed by more than 7%.

Conclusions

Despite a variety of shortcomings in the current study, it is quite clear BB safety self-management was effective in improving safety performance. Overall, the self-management procedures increased mean percent safe scores significantly from Baseline to Intervention. Moreover, both groups increased their mean percent safe score for three (Feedback) and two

(Feedforward) non-target behaviors, from Baseline to Intervention. Thus, BB safety self-management appears to be a successful approach in increasing safety-related work behaviors, and can be applied to as many as three safety behaviors with desirable side effects (i.e., response generalization).

Future Directions

Given the practical benefits of BB self-management, the current results offer an important springboard for future BB safety self-management research. This includes investigating the differential effects of the three components of the process: goal setting, feedback, and self-monitoring. At this stage of BB safety self-management little is known about the relative contribution of the various components of BB safety self-management. Future studies should assess which of these three elements are necessary and whether the additional elements could increase effectiveness.

Future studies with BB safety self-management should attempt to directly assess employee goals. These include studies that have workers complete a goal setting worksheet, and/or comparing participative versus assigned goal setting within a BB safety self-management framework.

Since the miners appeared to use their individualized feedback to alter their self-observations and subsequent safety performance, future studies should attempt to manipulate the type (e.g., false feedback, social comparison feedback, or accurate feedback), and amount (e.g., monthly, weekly, or daily) of individual feedback. What if the miners were given false feedback (i.e., reflecting lower or higher than actual performance) on their safety performance? Does the optimal individual feedback reflect actual observations, self-observations, or both? What would the addition of social comparison feedback add to the effectiveness of a BB safety-self-

management program?

From a practical standpoint, keeping employees safe is the mission of BB safety research. Yet, little has been done with solitary workers and workers who are not directly supervised. The typical BB safety intervention involves a *peer* observation and feedback process. Without peers to do BB observations, safety self-management is all we have. Safety self-management may be the only intervention for use with this population. It is hoped the current study adds meaningfully to the existing body of safety literature and provides important directions for future research with solitary workers.

REFERENCES

- Adam, E. E. (1975). Behavior modification in quality control. *Academy of Management Journal*, 18, p.662-679.
- Aronson, E. (1999). The power of self-persuasion. *American Psychologist*, 54, p.875-884.
- Austin, J., & Wilson, K. G. (2002). Response-response relationships in organizational behavior management. *Journal of Organizational Behavior Management*, 21(4).
- Bagozzi, R. P. (1992) The self-regulation of attitudes, intentions, and behavior. *Social Psychology Quarterly*, 55(2), p.178-204.
- Baker, S. P., Conroy, C., & Johnston, J. J. (1992). Occupational injury prevention. *Journal of Safety Research*, 23(2), p.129-133.
- Baker, R. C., & Kirschenbaum, D. S., (1993). Self-monitoring may be necessary for successful weight control. *Behavior Therapy*, 24, p.377-394.
- Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes*, 50, p.248-287.
- Bernardin, H. J., & Orban, J. A. (1990). Leniency effect as a function of rating format, purpose of appraisal, and rater individual differences. *Journal of Business and Psychology*, 5, p.197-211.
- Binswanger, H. (1991). Volition as cognitive self-regulation. *Organizational Behavior & Human Decision Processes*, 50(2), p.154-178.
- Boyce, T. E., & Geller, E. S. (1999). Attempts to increase vehicular safety-belt use among industry workers: What can we learn from our failures? *Journal of Organizational Behavior Management*, 19(3), p.27-44.

- Cambell, D. T. (1957). Factors relevant to the validity of experiments in social settings. *Psychological Bulletin*, 54, p.279-312.
- Cervone, D., & Wood, R. (1995). Goals, feedback, and the differential influence of self-regulatory processes on cognitively complex performance. *Cognitive Therapy & Research*, 19(5), p.519-545.
- Cohen, H. H., & Jensen, R. C. (1984). Measuring the effectiveness of an industrial lift truck safety training program. *Journal of Safety Research*, 15, p.125-135.
- Cromier, W. H., & Cromier, L. S. (1991). *Interviewing strategies for helpers: fundamental skills and cognitive behavioral interventions*. Monterey, CA: Brooks/Cole.
- Christensen, L. B. (1991). *Experimental methodology*, 5th ed. Needham Heights, MA: Allyn and Bacon.
- Cialdini, R. B. (2001). *Influence: Science and practice* (4th ed). Needham Heights, MA: Allyn & Bacon.
- Curry, S. (1993). Self-help interventions for smoking cessation. *Journal of Consulting and Clinical Psychology*, 61, p.790-803.
- Daniels, A. C. (1989). *Performance management: improving quality productivity through positive reinforcement*. Tucker, GA: Performance Management Publications.
- Daniels, A. C. (2000). *Bringing out the best in people* (2nd ed). New York: McGraw-Hill, Inc.
- Daniels, A. C. (2001). *Other people's habits: How to use positive reinforcement to bring out the best in people around you*. New York: McGraw-Hill.
- DePasquale, J. P., & Geller, E. S. (1999). Critical success factors for behavior-based safety: A study of twenty industry-wide applications. *Journal of Safety Research*, 30(4), p.237-249.

- DePasquale, J. P., & Geller, E. S. (2001). Intervening to improve driving instruction: Should behavioral feedback be an antecedent or a consequence? *International Journal of Behavioral Safety, 1*, p.11-14.
- Ericsson, K. A., Krampe, R., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*(3), p.361-406.
- Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford CA: Stanford University Press.
- Ford, J. E. (1980). A classification system for feedback procedures. *Journal of Organizational Behavior Management, 2*(3), p.183-191.
- Garvin, R.B., Alcorn, J.D., & Faulkner, K.K. (1990). Behavioral strategies for alcohol abuse prevention with high-risk college males. *Journal of Alcohol & Drug Education, 36*(1), p.23-34.
- Geller, E. S. (1996). *The psychology of safety: How to improve behaviors and attitudes*. Radnor, PA: Chilton Book Company.
- Geller, E. S. (1998a). *Application of behavior analysis to prevent injuries from vehicle crashes* (2nd ed.). Monograph, Cambridge, MA: Cambridge Center for Behavioral Studies.
- Geller, E. S. (1998b). *Beyond safety accountability: How to increase personal responsibility*. Neenah, WI: J.J. Keller & Associates, Inc.
- Geller, E. S. (1998c). *Understanding behavior-based safety: Step-by-step methods to improve your workplace* (Second Edition). Neenah, WI: J. J. Keller & Associates, Inc.
- Geller, E. S. (1999). Behavior-based safety: Confusion, controversy, and clarification. *Occupational Health & Safety, 68*(1), p.40, 42, 44, 46, 48-49.
- Geller, E. S. (2001). *The psychology of safety handbook*. Boca Raton, FL: CRC Press.

- Geller, E. S. (2002a). *Working safe: How to help people actively care for health and safety* (2nd ed.). Boca Raton, FL: CRC Press, Inc.
- Geller, E. S. (2002b). *The participation factor: How to increase involvement in occupational safety*. Des Plaines, IL: The American Society of Safety Engineers.
- Geller, E. S. (2002c). From ecological behaviorism to response generalization: Where should we make distinctions? *Journal of Organizational Behavior Management*, 21(4).
- Geller, E. S., & Clarke, S. W. (1999). Safety self-management: A key behavior-based process for injury prevention. *Professional Safety*, 44(7), p.29-33.
- Harris, M. M., & Schaubroeck, J. (1988). A meta-analysis of self-supervisor, self-peer, and peer-supervisor rating. *Personnel Psychology*, 41, p.43-62.
- Hamner, W. C., & Harnett, D. L. (1974). Goal-setting, performance, and satisfaction in independent task. *Organizational Behavior and Human Performance*, 12, p.217-230.
- Hefferman, T., & Richards, C. S. (1981). Self-control of study behavior: Identification and evaluation of natural methods. *Journal of Counseling Psychology*, 28, p.361-364.
- Heins, E. D., Lloyd, J. W., & Hallahan, D. P. (1986). Cued and noncued self-recording of attention to task. *Behavior Modification*, 10, p.235-254.
- Heinzelman, F., & Bagley, R. W. (1970). Response to physical activity programs and their effects on health behavior. *Public Health Reports*, 85, p.905-911.
- Hutchins, N., & Boyce, T. E. (2002). Response generalization in behavioral safety: Fact or Fiction? *Journal of Organizational Management*, 21(4).
- Holman, J., & Baer, D. M., (1979). Facilitating generalization of on-task behavior through self-monitoring of academic tasks. *Journal of Autism and Developmental Disorders*, 9, p.429-446.

- Ivancevich, J. M. (1977). Different goal setting treatments and their effect on performance and job satisfaction. *Academy of Management Journal*, 20, p. 287-300.
- Jonah, B. A. (1989, November). *Occupant restraint use in Canada: past, present and future*. Invited address to the SWOV Institute for Road Safety Research, Leidschendam, The Netherlands.
- Kazdin, A. E., (1993). Evaluation in clinical practice: Clinically sensitive and systematic methods of treatment delivery. *Behavior Therapy*, 24, p.11-45.
- Kazdin, A. E. (2001). *Behavior modification in applied settings* (8th ed). Belmont, CA: Wadsworth.
- Kirby, K. C., Fowler, S. A., & Baer, D. M., (1991). Reactivity in self-recording: Obtrusiveness of recording procedure and peer comments. *Journal of Applied Behavior Analysis*, 24, p.487-498.
- Kirschenbaum, D. S., Ordman, A. M., Tomarken, A. J., & Holtzbauer, R. (1982). Effects of differential self-monitoring and level of mastery of sports performance: Brain power bowling. *Cognitive Therapy and Research*, 6, p.335-342.
- Krause, T. R., Hidley, J. H., & Hodson, S. J. (1996). *The behavior-based safety process: Managing involvement for an injury-free culture* (2nd ed.). New York: Van Nostrand Reinhold.
- Kreitner, R. (1981/1982). The feedforward and feedback control of job performance through organizational behavior management (OBM). *Journal of Organizational Behavior Management*, 3(2), p.3-21.
- Latham, G. P., & Locke, E. A. (1991). Self-Regulation through goal setting. *Organization Behavior & Human Decision Processes*, 50, p.212-247.

- Latham, G. P., & Kline, S. B. (1974). Improving job performance through training and goal setting. *Journal of Applied Psychology, 59*, p.187-191.
- Latham, G., & Yukl, G. (1975). A review of research on the application of goal-setting in organizations. *Academy of Management Journal, 18*, p.824-845.
- Lau, W. Y, Bradley, L., & Parr, G. (1993). The effects of a self-monitoring process on college students' learning in an introductory statistics course. *Journal of Experimental Education, 62(1)*, p.26-40.
- Lawson, D. M., & Rhodes, E. C. (1981, November). *Behavioral self-control and maintenance of aerobic exercise: A retrospective study of self-initiated attempts to improve physical fitness*. Paper presented at the annual meeting of the Association for the Advancement of Behavior Therapy, Toronto.
- Locke, E. A. (1968). Toward a theory of task motivation and incentives. *Organizational Behavior and Human Performance, 3*, p.157-189.
- Locke, E., & Latham, G. (1990). *A theory of goal setting and task performance*. New Jersey: Prentice-Hall.
- Ludwig, T. D., & Geller, E. S. (1997). Improving driving practices of professional drivers: Participation versus assigned goal setting and response generalization. *Journal of Applied Psychology, 82*, p.253-261.
- Ludwig, T. D., & Geller, E. S. (1999). Behavior change among agents of a community safety program: Pizza deliverers advocate safety-belt use. *Journal of Organizational Behavior Management, 19(2)*, p.3-24.

- Ludwig, T. D., Geller, E. S. (2001). *Intervening to improve the safety of occupational driving: A behavior-change model and review of the literature*. Binghamton, NY: The Hawthorne Press, Inc.
- Ludwig, T. D. (2002). On the necessity of structure in an arbitrary world: using congruent schedules of reinforcement to describe response generalization. *Journal of Organizational Behavior Management*, 21(4).
- Mahoney, M. J. (1971). The self-management of covert behavior: A case study. *Behavior Therapy*, 2, p.575-578.
- Mahoney, M. J. (1972). Research issues in self-management. *Behavior Therapy*, 3, p.45-63.
- Mahoney, M. J., Moura, N. G., & Wade, T. C. (1973). Relative efficacy of self-reward, self-punishment, and self-monitoring techniques for weight loss. *Journal of Consulting and Clinical Psychology*, 40, p.404-407.
- McCaul, K. D., Glasgow, R. E., & O'Neill, H. K. (1992). The problem of creating habits: Establishing health - protective dental behaviors. *Health Psychology*, 11(2), p.101-110.
- McSween, T. E. (1985). *The values-based safety process: Improving your safety culture with a behavioral approach*. New York: Van Nostrand Reinhold.
- Mento, A. J., Steel, R. P., & Karren, R. J. (1987). A meta-analytic study of the effects of goal setting on task performance: 1966-1984. *Organizational Behavior and Human Decision Processes*, 39, p.52-83.
- Migliore, R. H. (1977). *Blue collar to top executive*. Washington, D. C. Bureau of National Affairs.
- Miller, T. R. (1997). Estimating the costs of injury to U.S. employers. *Journal of Safety Research*, 28(1), 1-13.

- Mine Safety and Health Administration, (2001a). *Metal/nonmetal fatalities for the 20th century*.
<http://www.msha.gov.centurystats/mnstats.htm> (November, 2001).
- Mine Safety and Health Administration, (2001b). *Number of operator injuries, injury-incidence rates, average number of employees, and employee hours, by work location and mineral industry*. <http://www.msha.gov/STATS/PART50/WQ/2000/WQ005T02.htm> (November, 2001).
- Moss, M. K., & Arend, R. A. (1977). Self-directed contact desensitization. *Journal of Consulting and Clinical Psychology*, 45, p.730-738.
- National Committee for Injury Prevention and Control. (1989). *Injury prevention: Meeting the challenge*. New York: Oxford University Press.
- National Safety Council. (1988). *Accident facts*. Chicago: National Safety Council.
- National Safety Council. (1994). *Accident facts*. Chicago: National Safety Council.
- National Safety Council. (1995). *Accident facts*. Chicago: National Safety Council.
- Nelson, R. O. (1977). Methodological issues in assessment via self-monitoring. In J. D. Cone & R. P. Hawkins (Eds.), *Behavioral assessment: New directions in clinical psychology*. New York: Brunner/Mazel.
- Neubert, M. J. (1998). The value of feedback and goal setting over goal setting alone and potential moderators of this effect: A meta-analysis. *Human performance*, 11(4), p.321-335.
- Petersen, D. (1989). *Safe behavior reinforcement*. Goshen, NY: Aloray, Inc.
- Peterson, L. (1983). Failure in self-control. In E. B. Foa & P. M. G. Emmelkamp (Eds.), *Failures in behavior therapy*. New York: Wiley.

- Perri, M. G., & Richards, C. S. (1977). An investigation of naturally occurring episodes of self-controlled behaviors. *Journal of Counseling Psychology, 24*, p.178-183.
- Perri, M. G., McAllister, D. A., Gange, J. J., Jordan, R. C., McAdoo, N. G., & Nezu, A. M. (1987). Effects of four maintenance programs on the long-term management of obesity. *Journal of Consulting and Clinical Psychology, 55*, p.615-617.
- Saarela, K. L. (1990). An intervention program utilizing small groups: A comparative study. *Journal of Safety Research, 21*, p.149-156.
- Shiffman, S. (1984). Coping with temptations to smoke. *Journal of Consulting and Clinical Psychology, 52*, p.261-267.
- Sitharthan, T., Kavanagh, D.J., & Sayer, G. (1996) Moderating drinking by correspondence: An evaluation of a new method of intervention. *Addiction, 91*(3), p.345-355.
- Skinner, B. F. (1953) *Science and human behavior*. New York, NY: Macmillan.
- Sobell, L. S., & Sobell, M. B., (1995). *Guided self-change case study: Lisa*. Toronto, Canada: Addiction Research Council.
- Sohn, D., & Lanal, P. A., (1982). Self-reinforcement: Its reinforcing capability and its clinical utility. *Psychological Record, 32*, p.179-203.
- Staddon, J. (2001). *The new behaviorism: Mind, mechanism, and society*. Philadelphia, PA: Psychology Press.
- Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, p.349-367.
- Stuart, R. B. (1967). Behavioral control of overeating. *Behaviour Research and Therapy, 5*, p.357-365.

- Thorensen, C. E., & Mahoney, M. J. (1974). *Behavioral self-control*. New York: Holt, Rinehart and Winston.
- Tubbs, M. E. (1986). Goal setting: A meta-analytic examination of the empirical evidence. *Journal of Applied Psychology, 71*, p.474-483.
- U. S. Bureau of Labor Statistics (1997). Safety and health statistics. *Occupational Safety and Health Home Page*.
- U. S. Bureau of Labor Statistics, (2001a). *Fatal occupational injuries by industry, 1995-2001*. <http://www.bls.gov/iif/oshec/cfoi/cftb141.pdf> (November, 2001).
- U. S. Bureau of Labor Statistics, (2001b). *National census of fatal occupational injuries in 2000*. <http://www.bls.gov/oshow/cfoi/cfnr0007.pdf> (November, 2001).
- U. S. Bureau of Labor Statistics, (2001c). *Workplace injuries and illnesses in 1999*. <http://www.bls.gov/iif.oshwc.osh/os/osnr0011.pdf> (November, 2001).
- Van Houten, R., & Nau, P. A. (1983). Feedback interventions and driving speed: A parametric and comparative analysis. *Journal of Applied Behavior Analysis, 16*, p.253-281.
- Van Houten, R., Nau, P. A., & Marini, Z. (1980). An analysis of public posting in reducing speeding behavior on an urban highway. *Journal of Applied Behavior Analysis, 13*, 383-396.
- Waller, J. A., & Klein, D. (1971). Society, energy, and injury: Inevitable triad? In *Research directions toward the reduction of injury*. Washington, DC: U.S. Department of Health, Education, and Welfare.
- Watson, D.L., & Tharp, R.G., (1997). *Self-directed behavior: Self-modification for personal adjustment* (7th ed.) Monterey, CA: Brooks/Cole.

- Williams, J. H., & Geller, E. S. (2000). Behavior-based intervention for occupational safety: Critical impact of social comparison feedback. *Journal of Safety Research*, 31, p. 135-142.
- Wood, Y. R., Hardin, M., & Wong, E. (1984, January). *Social network influences on smoking cessation*. Paper presented at the meeting of the Western Psychological Association, Los Angeles, CA.
- Zohar, D., Cohen, A., & Azar, N. (1980). Promoting increased use of ear protectors in noise through information feedback. *Human Factors*, 22(1), p.69-79.

Table 1.

Reliability Estimates for Observations of Safe and At-Risk Behaviors During Baseline

	TARGET			NON-TARGET				
	Safety Glasses	Ear Plugs	Hard Hat	Boots	Gloves	Dust Mask	Knee Position During Lifts	Body Position During Lifts
Number of Observations by Two RAs	215	80	0	262	231	5	15	19
% Agreement for Safe Behaviors	99.5%	100%	-	100%	93.3%	100%	87.1%	87.6%
Number of Observations by Two RAs	47	196	269	7	41	261	29	22
% Agreement for At-Risk Behaviors	100%	100%	100%	99.8%	100%	95.7%	96.9%	96%

Table 2.

Reliability Estimates for Observations of Safe and At-Risk Behaviors During Intervention

	TARGET			NON-TARGET				
	Safety Glasses	Ear Plugs	Hard Hat	Boots	Gloves	Dust Mask	Knee Position During Lifts	Body Position During Lifts
Number of Observations by Two RAs	162	80	0	189	165	36	28	43
% Agreement for Safe Behaviors	96.3%	95%	-	94.7%	92.1%	91.6%	92.9%	93%
Number of Observations by Two RAs	18	96	188	0	16	155	24	21
% Agreement for At-Risk Behaviors	96.5%	96.8%	100%	-	93.8%	100%	91.7%	95.2%

Table 3.

Reliability Estimates for Observations of Safe and At-Risk Safety During Withdrawal

	TARGET			NON-TARGET				
	Safety Glasses	Ear Plugs	Hard Hat	Boots	Gloves	Dust Mask	Knee Position During Lifts	Body Position During Lifts
Number of Observations by Two RAs	151	57	0	217	189	10	37	53
% Agreement for Safe Behaviors	100%	85.7%	-	100%	100%	90%	83.3%	94.7%
Number of Observations by Two RAs	43	96	212	0	26	132	48	32
% Agreement for At-Risk Behaviors	100%	94.8%	100%	-	88.5%	100%	89.6%	87.5%

Table 4.

Mean Percent Safe Scores During Baseline for Each Target Safety Behavior for both the Feedforward and Feedback Groups

	Feedforward Group	Feedback Group	Chi-Square Statistic
Safety Glasses	77.6%	83.6%	$X^2_{(1)}=3.04, p>.10$
Ear Plugs	24.5%	29.3%	$X^2_{(1)}=1.58, p>.10$
Dust Mask	.42%	.34%	$X^2_{(1)}=.023, p>.10$

Table 5.

Mean Percent Safe Scores During Baseline for Each Non-Target Safety Behavior for both the Feedforward and Feedback Groups

	Feedforward Group	Feedback Group	Chi-Square Statistic
Hard Hat	0%	0%	<i>No Difference</i>
Boots	100%	99.7%	$X^2_{(1)}=.588, p>.10$
Gloves	89.5%	84.7%	$X^2_{(1)}=2.64, p>.10$
Knee Position During Lifts	33.8%	31.4%	$X^2_{(1)}=.105, p>.10$
Body Position During Lifts	51%%	52.9%	$X^2_{(1)}=.086, p>.10$

Table 6.

Demographic Characteristics for both the Feedforward and Feedback Groups

	Feedforward Group	Feedback Group	One-Way ANOVA
Age	33.5 years (19-47)	33.3 years (18-45)	$F = .019, p > .10$
Ethnicity/Gender	100% Caucasian Male	100% Caucasian male	No Difference
Length employed at the Virginia Tech Quarry (range)	4.9 years (.5-17)	5.4 years (.08-12)	$F = .035, p > .10$
Length employed in mining operations (range)	5.3 years (.5-17)	7.4 years (.08-12)	$F = 2.28, p > .10$
Safety incidents, in the last year, in which participants had to takes time-off work (range)	.5 Incidents (0-1)	.4 Incidents (0-1)	$F = .043, p > .10$
Safety incidents, in the three years, in which participants had to takes time-off work (range)	1 Incident (0-3)	1 Incident (0-3)	No Difference

Table 7.

Answers for Each Participant (Feedforward and Feedback groups) on the Training Presentation Manipulation Check

Participant Code	We talked about the _____ approach of goal setting? a. SMART b. DO IT c. Easy d. Difficult	I will receive _____ for each completed self-observation checklist? a. \$6.00 b. \$2.00 c. \$1.00	I will complete a checklist at the _____ of my shift for the day? a. Beginning (blue checklist) b. End (gold checklist)	At-risk behaviors are usually easier and more convenient to perform than safe behaviors? a. TRUE b. FALSE
AUCO04	A	C	B	A
MISE12*	A	C	B	A
PAGO10	A	C	B	A
PELA09	A	C	B	A
PELI02	A	C	B	A
RAMA04	A	C	B	A
RAMO02	A	C	B	A
Feedback Group Totals	100%	100%	100%	100%
BLCA01	A	C	A	A
BLCA12	A	C	A	A
BLNA07	A	C	A	A
BLWE06	A	C	A	A
GIPE03	A	C	A	A
MOGE12	A	C	A	A
RALA09	A	C	A	A
ROLO05*	A	C	A	A
Feedforward Group Totals	100%	100%	100%	100%

Note: Employees marked with an * started employment 4 weeks prior to Intervention.

Table 8.

Mean Percent Safe Scores for Each Target Behavior Across Baseline and Intervention phases

	Baseline	Intervention	% Change	Chi-Square Statistic
Feedforward Group <i>Safety Glasses</i>	77.6%	85.2%	+7.6%	$X^2_{(1)}=4.52,$ $p<.05$
Feedforward Group <i>Ear Plugs</i>	24.5%	47.3%	+22.8%	$X^2_{(1)}=26.75,$ $p<.01$
Feedforward Group <i>Dust Mask</i>	.42%	5.1%	+4.7%	$X^2_{(1)}=9.62,$ $p<.01$
Feedback Group <i>Safety Glasses</i>	83.6%	95.4%	+10.9%	$X^2_{(1)}=19.72,$ $p<.01$
Feedback Group <i>Ear Plugs</i>	29.3%	53.3%	+24%	$X^2_{(1)}=33.12,$ $p<.01$
Feedback Group <i>Dust Mask</i>	.34%	8.1%	+7.8%	$X^2_{(1)}=21.67,$ $p<.01$

Table 9.

Mean Percent Safe Scores for Each Target Behavior Across Intervention and Withdrawal phases

	Intervention	Withdrawal	% Change	Chi-Square Statistic
FeedForward Group <i>Safety Glasses</i>	85.2%	84.1%	-1.1%	$X^2_{(1)}=.149,$ $p>.10$
Feedforward Group <i>Ear Plugs</i>	47.3%	34.2%	-13.1%	$X^2_{(1)}=9.65,$ $p<.01$
Feedforward Group <i>Dust Mask</i>	5.1%	1.8%	3.3%	$X^2_{(1)}=4.81,$ $p<.05$
Feedback Group <i>Safety Glasses</i>	95.4%	93.5%	-1.9%	$X^2_{(1)}=.974,$ $p>.10$
Feedback Group <i>Ear Plugs</i>	53.3%	37.3%	-16%	$X^2_{(1)}=11.05,$ $p<.01$
Feedback Group <i>Dust Mask</i>	8.1%	1.0%	-7.1%	$X^2_{(1)}=16.16,$ $p<.01$

Table 10.

Mean Safety Scores for Each Non-Target Behavior Across Baseline and Intervention phases

	Baseline	Intervention	% Change	Chi-Square Statistic
FeedForward Group <i>Hard Hat</i>	0%	0%	-	<i>No Difference</i>
Feedforward Group <i>Boots</i>	100%	100%	-	$X^2_{(1)}=2.01,$ $p>.10$
Feedforward Group <i>Gloves</i>	89.5%	92.4%	+2.9%	$X^2_{(1)}=1.25,$ $p>.10$
Feedforward Group <i>Knee Position During Lifts</i>	33.8%	68.3%	+34.5%	$X^2_{(1)}=23.15,$ $p<.01$
Feedforward Group <i>Body Position During Lifts</i>	51%	69.4%	+18.4%	$X^2_{(1)}=7.3,$ $p<.01$
Feedback Group <i>Hard Hat</i>	0%	0%	-	<i>No Difference</i>
Feedback Group <i>Boots</i>	99.7%	100%	+.3%	$X^2_{(1)}=.89,$ $p>.10$
Feedback Group <i>Glove</i>	84.7%	91.2%	+6.5%	$X^2_{(1)}=5.34,$ $p<.05$
Feedback Group <i>Knee Position During Lifts</i>	31.4%	64.8%	+33.4%	$X^2_{(1)}=23.04,$ $p<.01$
Feedback Group <i>Body Position During Lifts</i>	52.9%	71.2%	+18.3%	$X^2_{(1)}=7.45,$ $p<.01$

Table 11.

Participation Frequency and Percentages, for Each Participant, for both the Feedforward and Feedback Groups During the Intervention Phase

Participant Code	Week 1 (# of forms completed)	Week 2 (# of forms completed)	Week 3 (# of forms completed)	Week 4 (# of forms completed)	Participation Percentage
AUCO04	4	5	5	2	90% (18/20)
MISE12*	4	1	0	0	20% (5/20)
PAGO10	5	5	5	5	100% (20/20)
PELA09	4	5	5	5	95% (19/20)
PELI02	4	5	5	5	95% (19/20)
RAMA04	5	5	5	5	100% (20/20)
RAMO02	5	5	5	0	75% (15/20)
Feedback Group Totals	85.7% (30/35)	88.6% (31/35)	85.7% (30/35)	62.9% (22/35)	80.7% (113/140)
BLCA01	4	5	5	5	95% (19/20)
BLCA12	5	5	5	5	100% (20/20)
BLNA07	4	5	5	4	90% (18/20)
BLWE06	5	5	5	4	95% (19/20)
GIPE03	3	5	5	5	90% (18/20)
MOGE12	4	5	4	4	85% (17/20)
RALA09	5	4	5	4	90% (18/20)
ROLO05*	3	2	2	3	50% (10/20)
Feedforward Group Totals	82.5% (33/40)	90% (36/40)	77.5% (31/40)	85% (34/40)	83.8% (134/160)

Note: Employees marked with an * started employment 4 weeks prior to Intervention.

Table 12.

Participant Responses on the Post-Intervention Survey for both the Feedforward and Feedback groups

Participant Code	When did you complete your checklist(s)? A. Before I started my shift B. At the end of my shift	Did you discuss your feedback with coworkers A. Yes B. No	If yes to question 2, how often did you discuss your feedback with your coworkers? A. Each week B. Several Times C. Once	Did you change your safety behaviors because you knew people were observing you? A. Yes B. No	I believe this safety program was very beneficial for my safety? A. Strongly Disagree B. Disagree C. Neutral D. Agree E. Strongly Agree	Did you find the feedback on your safety behaviors useful? A. Yes B. No
AUCO04	<i>B</i>	<i>A</i>	<i>A</i>	<i>B</i>	<i>D</i>	<i>A</i>
MISE12*	<i>B</i>	<i>A</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>A</i>
PAGO10	<i>B</i>	<i>A</i>	<i>A</i>	<i>B</i>	<i>D</i>	<i>A</i>
PELA09	<i>B</i>	<i>A</i>	<i>A</i>	<i>B</i>	<i>B</i>	<i>B</i>
PELI02	<i>B</i>	<i>A</i>	<i>B</i>	<i>B</i>	<i>A</i>	<i>B</i>
RAMA04	<i>B</i>	<i>B</i>	-	<i>B</i>	<i>C</i>	<i>A</i>
RAMO02	<i>B</i>	<i>A</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>A</i>
Feedback Group Totals	100% at end of shift	87.5% discussed feedback	85.7% discussed feedback each week	100% no reactance	28.6% Agree, 42.9% Neutral, 28.6% Disagree	71.4% found feedback useful
BLCA01	<i>A</i>	<i>A</i>	<i>A</i>	<i>B</i>	<i>D</i>	<i>A</i>
BLCA12	<i>A</i>	<i>B</i>	-	<i>B</i>	<i>C</i>	<i>A</i>
BLNA07	<i>A</i>	<i>A</i>	<i>B</i>	<i>B</i>	<i>C</i>	<i>A</i>
BLWE06	<i>A</i>	<i>A</i>	<i>B</i>	<i>B</i>	<i>D</i>	<i>A</i>
GIPE03	<i>A</i>	<i>B</i>	-	<i>B</i>	<i>C</i>	<i>A</i>
MOGE12	<i>A</i>	<i>B</i>	-	<i>B</i>	<i>D</i>	<i>A</i>
RALA09	<i>A</i>	<i>A</i>	<i>A</i>	<i>B</i>	<i>D</i>	<i>A</i>
ROLO05*	<i>A</i>	<i>B</i>	-	<i>B</i>	<i>D</i>	<i>A</i>
Feedforward Group Totals	100% At beginning of shift	50% discussed feedback	50% discussed feedback each week	100% no reactance	63.5% Agree, 36.5% Neutral	100% found feedback useful

Note: Employees marked with an * started employment 4 weeks prior to Intervention.

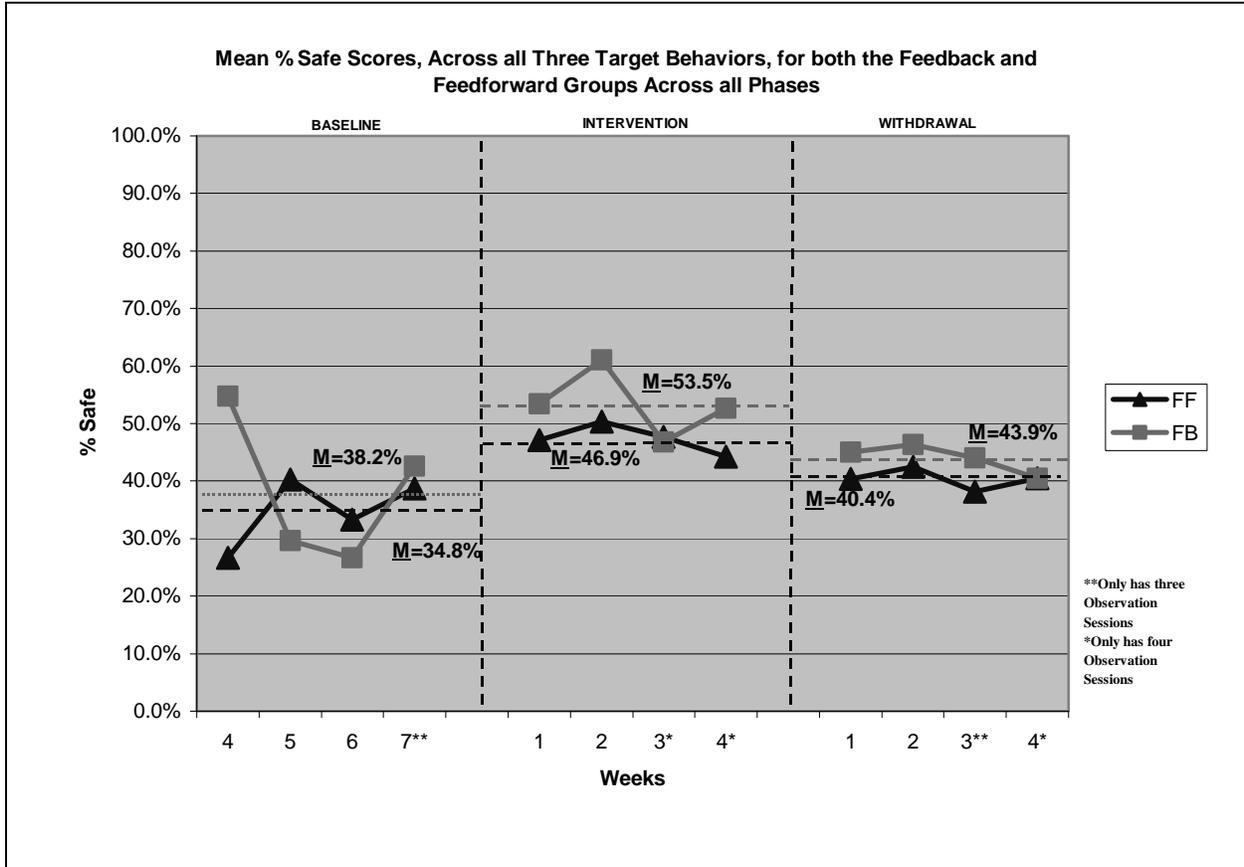


Figure 3. Displays the week-by-week mean percent safe scores across target behaviors for both the Feedforward and Feedback groups across all phases.

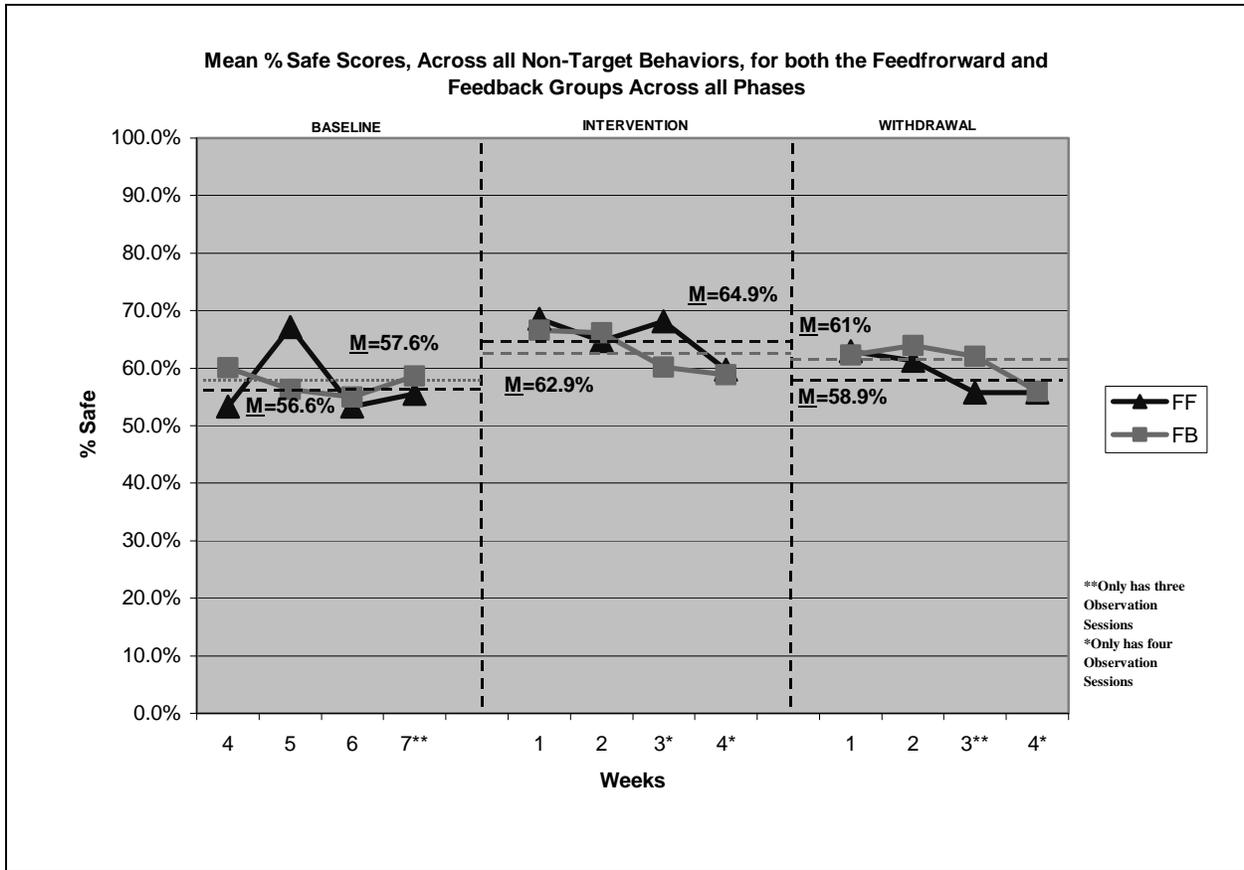


Figure 4. Displays the week-by-week mean percent safe scores across non-target behaviors for both the Feedforward and Feedback groups across all phases.

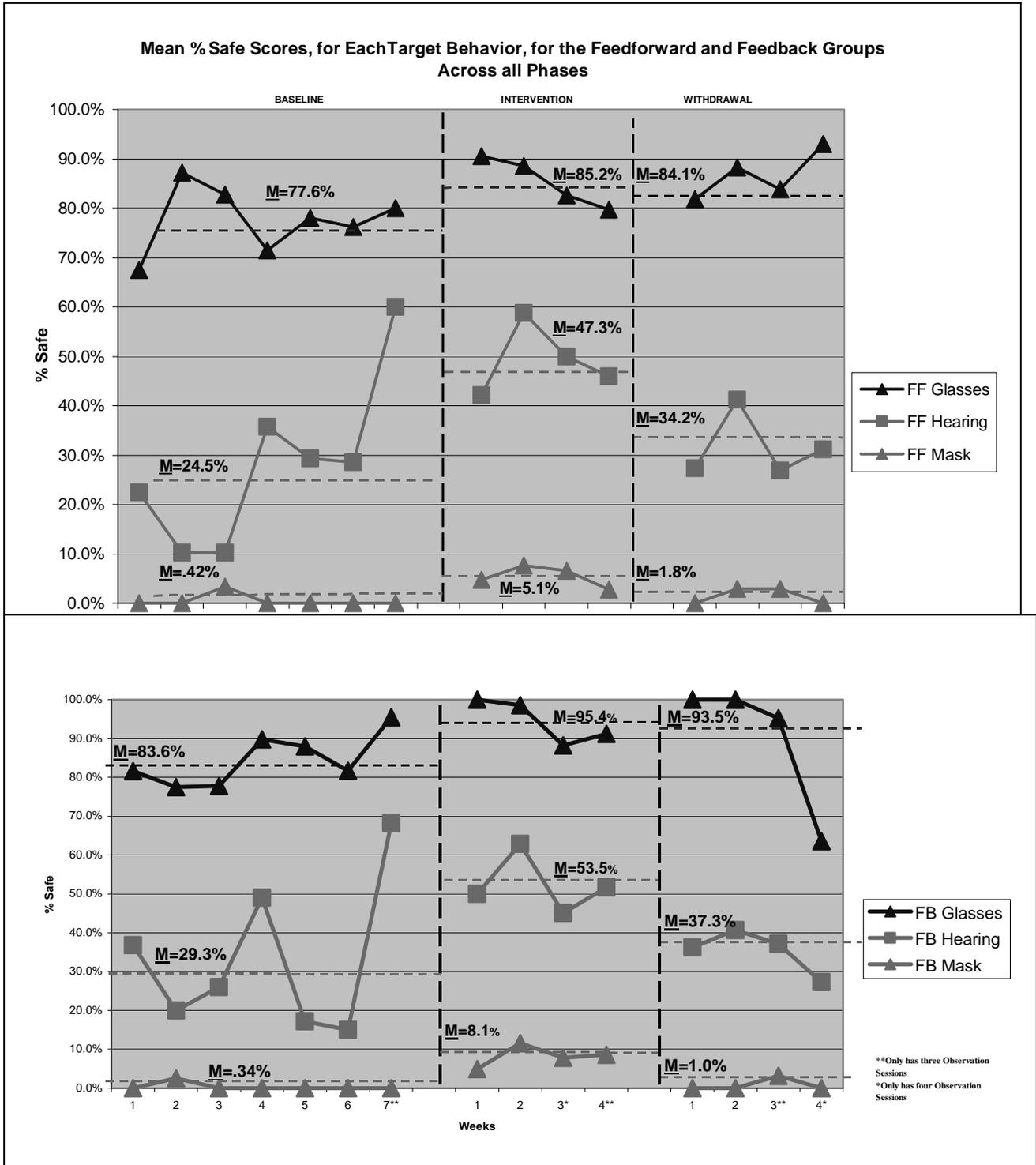


Figure 5. Displays week by week mean percent safe scores for each target behavior for both the Feedforward and Feedback groups across all phases.

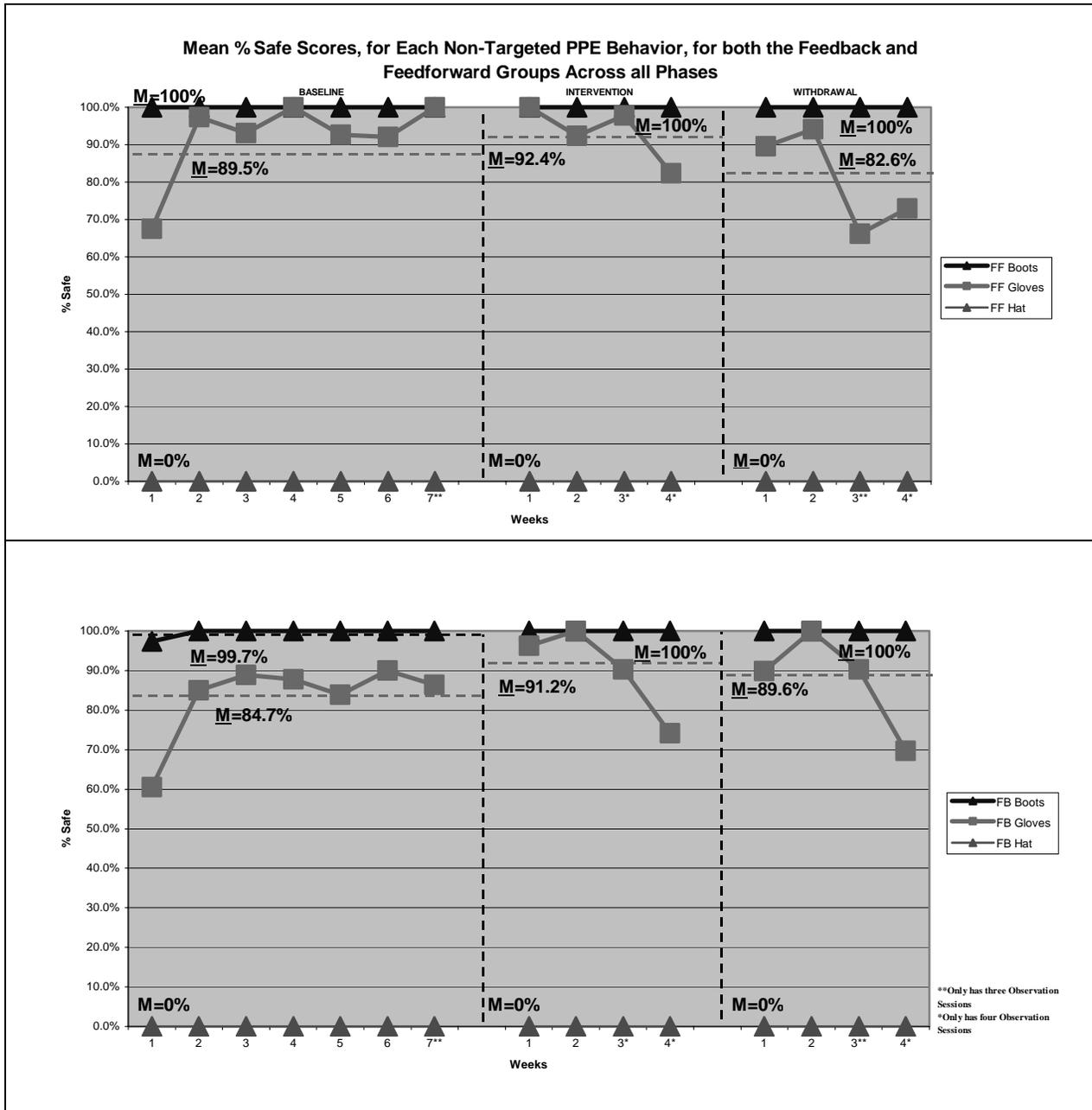


Figure 6. Displays week by week mean percent safe scores, for each non-target PPE behavior, for both the Feedforward and Feedback groups across all phases.

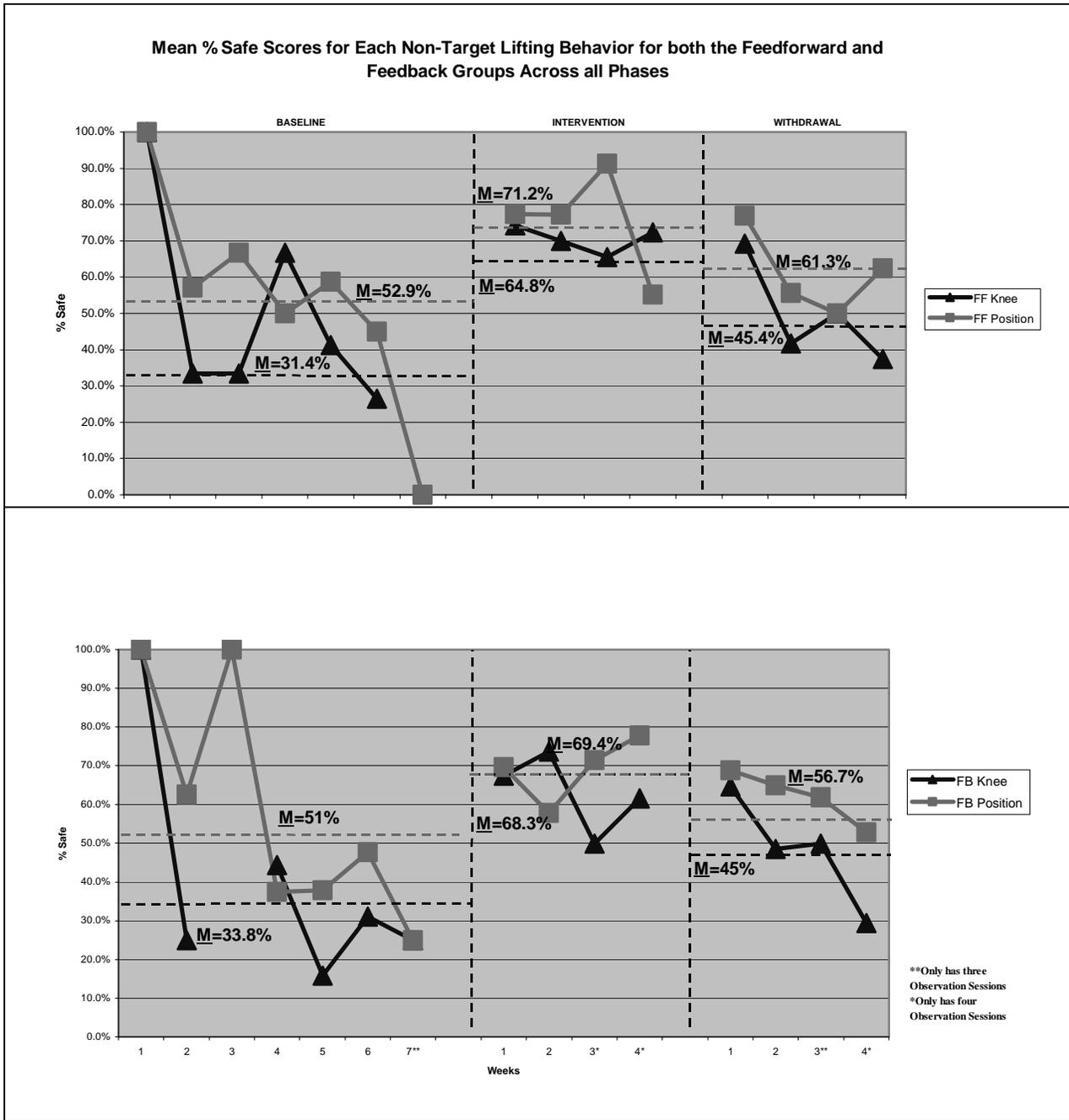


Figure 7. Displays week by week mean percent safe scores, for each non-target lifting behavior, for both the Feedforward and Feedback groups across all phases.

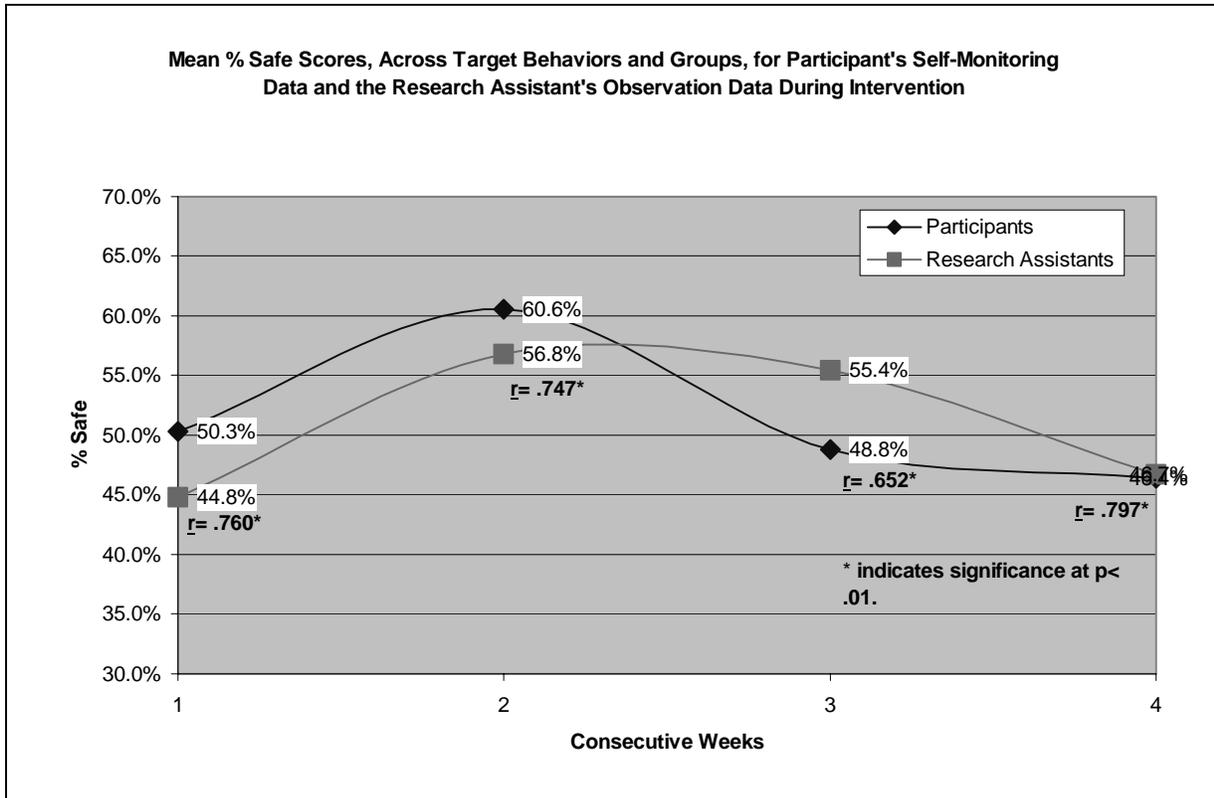


Figure 8. Displays mean percent safe scores, across target behaviors and groups, for participant's self-monitoring data and the research assistant's observation data during Intervention.

APPENDIX A:

Participant Informed Consent Form

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

**Informed Consent Form for
Participant of Investigative Projects**

1. THE PURPOSE OF THIS RESEARCH

You are invited to participate in a project that will attempt to increase safe work practices and decrease unsafe work practices at the Virginia Tech Quarry.

2. PROCEDURES

You will be asked to attend an initial training session, approximately one-hour in length, in which you will learn the fundamentals of a behavior-based safety process. At this meeting you will be asked to complete a two brief questionnaires. In addition, throughout your regular workday you will be required to perform some of the procedures you will learn about in the initial training sessions. Among these procedures will be techniques of self-observation, goal setting, and understanding how to interpret graphical data. Trained research assistants will be making behavioral observations on your safety performance.

3. RISKS & BENEFITS OF THIS PROJECT

We anticipate no risks associated with participation in this project. Your participation in this project will help assess the extent to which members of a community are willing and able to implement behavior-based safety process. It will also allow us to assess the extent to which such a process can become institutionalized within the contemporary community. It should be know that the data collected from self-observations and research assistants will not be used in any way to punish employees, based on this data. Furthermore, we trust you will benefit from an increase in safe work practices and a concomitant decrease in work-related injuries.

4. EXTENT OF THE ANONYMITY AND CONFIDENTIALITY

THE RESULTS OF THIS STUDY WILL BE KEPT STRICTLY CONFIDENTIAL. At no time will the researchers release your results in this study to anyone other than individuals working on the project without your written consent. The information you provide will have your name removed and only a coded subject number will identify you during analysis and any written reports of the research.

5. COMPENSATION

Your participation in this project will provide you with free behavior-based safety training and expert advise.

6. FREEDOM TO WITHDRAW

YOU ARE FREE TO WITHDRAW FROM THIS STUDY AT ANY TIME WITHOUT PENALTY.

7. APPROVAL OF RESEARCH

This research has been approved, by the Human Subjects Committee of the Department of Psychology and by the Institutional Review Board Virginia Polytechnic Institute and State University.

Faculty Advisor: E. Scott Geller	Phone: 231-6223
Chair, HSC: David W. Harrison	Phone: 231-4422
Project Manager, Jeffrey Hickman	Phone: 231-8145
Project Co-Manager, Albert Moore	Phone: 231-3080
Dr. David Moore Chair, IRB CVM Phase II	Phone: 231-4991

8. PARTICIPANT'S RESPONSIBILITIES

I know of no reason I cannot participate in this study. I have the responsibility of letting the researcher know of any discomfort or problems I have during the course of the study.

Signature & Date: _____

9. PARTICIPANT'S PERMISSION

I have read and understand the informed consent form and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

If I have any questions about this research, I will contact E. Scott Geller, Ph.D., 5100 Derring Hall, Dept. of Psychology, Virginia Tech. Phone: 231-6223.

By Signing this form I also agree not to discuss this procedure with anyone until I have been formally debriefed.

Name: _____

APPENDIX B:

Training Materials (demographic questionnaire, and brief quiz)

Brief Questionnaire

1. We talked about the _____ approach of goal setting?
a. SMART b. DO IT c. Easy d. Difficult
2. I will receive _____ for each completed self-observation checklist?
a. \$6.00 b. \$2.00 c. \$1.00
3. I will complete a checklist at the _____ of my shift for the day?
a. Beginning (blue checklist) b. End (gold checklist)
4. At-risk behaviors are usually easier and more convenient to perform than safe behaviors?
a. TRUE b. FALSE

DEMOGRAPHIC QUESTIONNAIRE

Please answer the following questions as honestly as possible. All forms will be collected and kept by the researcher. In no way will you be able to be identified. All responses will be completely confidential. Please circle the answer that best corresponded to you.

1. Please circle your gender (MALE/FEMALE)
2. Year you were born_____
3. Last two letters of your mother's maiden name_____
4. What is your ethnicity (please circle)
5. Caucasian/African-American/Hispanic/Asian/Other (please specify)_____
6. How many years have you been working at the Virginia Tech Quarry_____
7. How many years have you been working in mining operations_____
8. How many incidents have you had in the last year that involved taking time-off from work_____
9. How many incidents have you had in the last three years that involved taking time-off from work_____

APPENDIX C:
Participant Self-Monitoring Forms

Self-Management Checklist
Completed at the end of your shift for the day
Date: _____

First 2 letters of the city you were born in: _____
First 2 letters of your mother's maiden name: _____
Month you were born (for example if you were born in April it would be '04'): _____

_____% of the time I *worked* today with my **Hearing Protection** (please estimate)
_____% of the time I *worked* today with my **Dust Mask** (please estimate)
_____% of the time I *worked* today with my **Safety Goggles** (please estimate)
Comments: _____

Figure C1. Feedback self-monitoring form.

Self-Management Checklist
Completed before starting your shift for the day
Date: _____

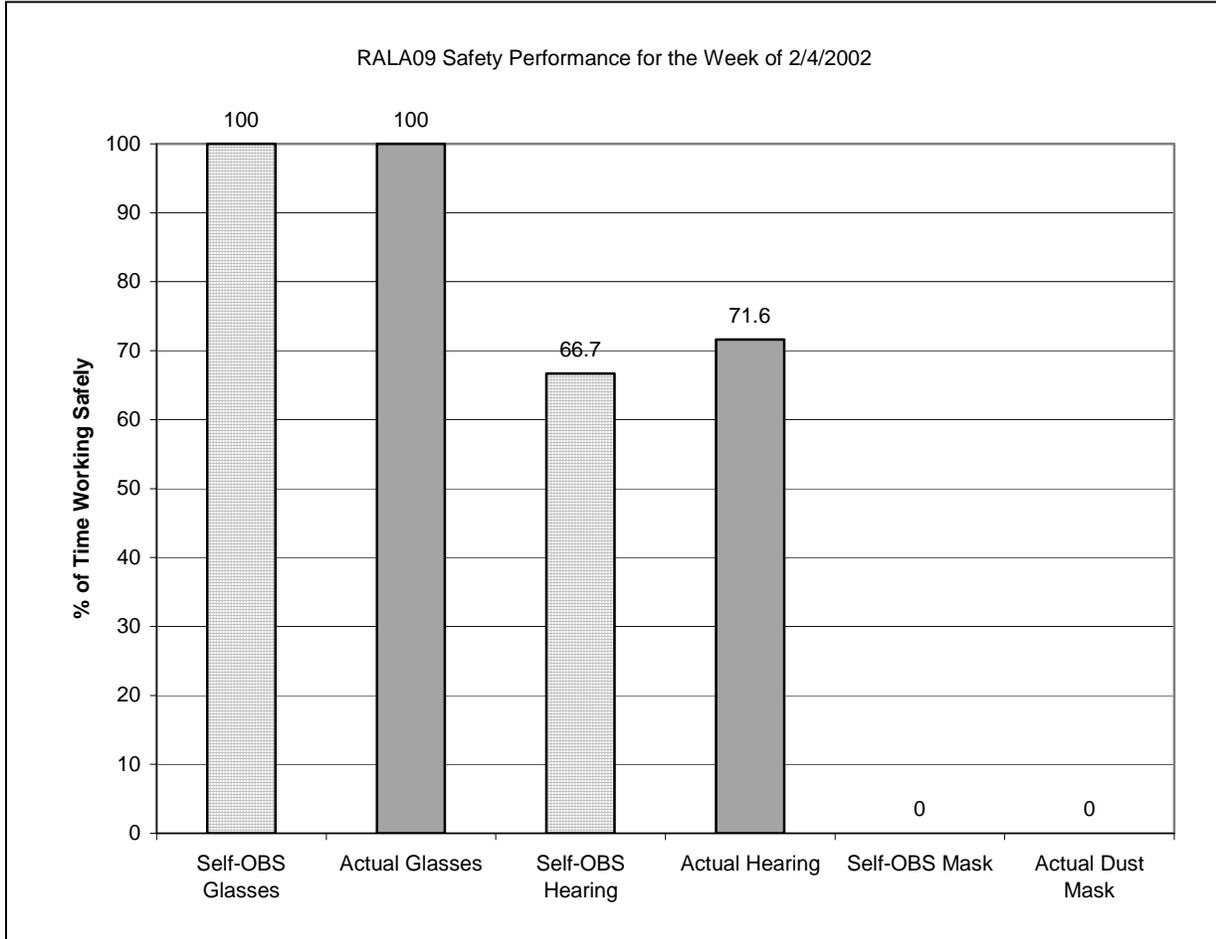
First 2 letters of the city you were born in: _____
First 2 letters of your mother's maiden name: _____
Month you were born (for example if you were born in April it would be '04'): _____

_____% of the time I *will* work today with my **Hearing Protection** (please estimate, put *N/A* if you believe you won't perform the behavior today)
_____% of the time I *will* work today with my **Dust Mask** (please estimate)
_____% of the time I *will* work today with my **Safety Goggles** (please estimate)
Comments: _____

Figure C2. Feedforward self-monitoring form.

APPENDIX D:

Participant feedback graphs and driver memo



PARTICIPANT MEMO

February 11, 2002

Dear RALA09,

Thank you for your participation in this innovative safety process. Your involvement in this process shows you care about your safety, and the safety for your coworkers. You completed 4 self-observations this week (2/4/02). You have earned a total of \$9.00.

Thank you for your participation,

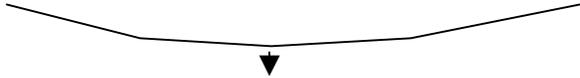
Jeff Hickman, Graduate Research Assistant
Center for Applied Behavior Systems
Virginia Tech

APPENDIX E:

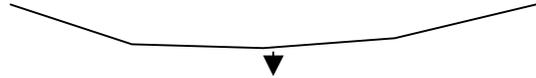
Research assistant's CBC and cutting room layout

VIEW OF CUTTING SHEDS

Breaking Room	P	P	B	B	R	A	B	M	P	M	R
	E	E	L	L	O	U	L	O	A	I	A
	L	L	C	N	L	C	W	G	G	S	L
	A	I	A	A	O	O	E	E	O	E	A
	0	0	1	0	0	0	0	1	1	1	0
	9	2	2	7	5	4	6	2	0	2	9

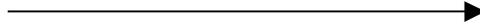


Cutting Room #1



Cutting Room #2

Mine Entrance



Research Assistant's CBC

Data Collectors Number:

Date:

Primary / Reliability

B=Breaking Room, C=Cutting Shed, O=Outside D=Drilling NW=Not Working

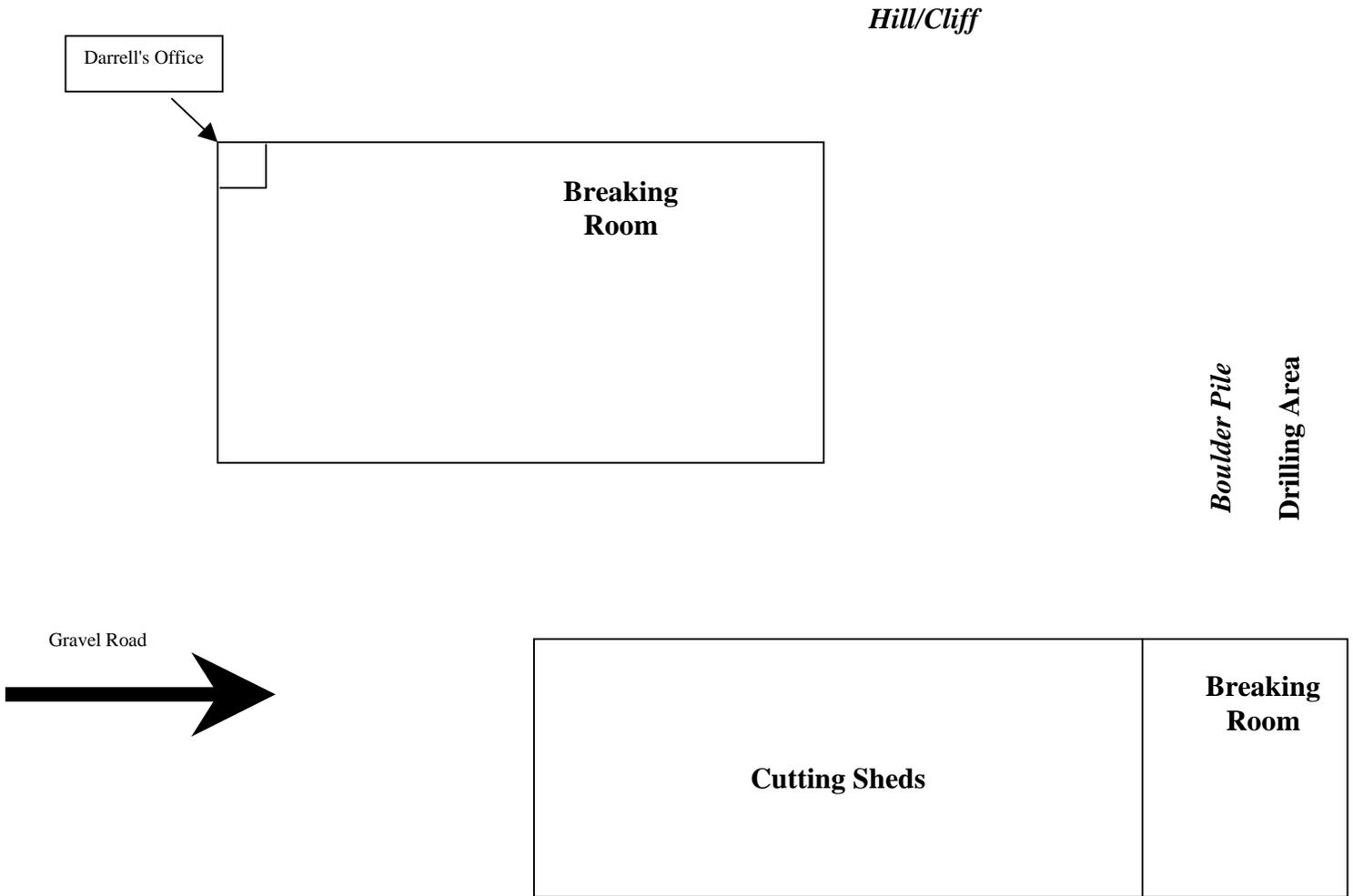
Employee Code	Working Condition	Glasses	Hearing	Hard-Hat	Steel-Toes	Leather Gloves	Dust Mask	Lifting	Body Position	Comments
AUCO04		S A	S A	S A	S A	S A	S A	S A	S A	
AUCO04		S A	S A	S A	S A	S A	S A	S A	S A	
AUCO04		S A	S A	S A	S A	S A	S A	S A	S A	
BLCA01		S A	S A	S A	S A	S A	S A	S A	S A	
BLCA01		S A	S A	S A	S A	S A	S A	S A	S A	
BLCA01		S A	S A	S A	S A	S A	S A	S A	S A	
BLCA12		S A	S A	S A	S A	S A	S A	S A	S A	
BLCA12		S A	S A	S A	S A	S A	S A	S A	S A	
BLCA12		S A	S A	S A	S A	S A	S A	S A	S A	
BLNA07		S A	S A	S A	S A	S A	S A	S A	S A	
BLNA07		S A	S A	S A	S A	S A	S A	S A	S A	
BLNA07		S A	S A	S A	S A	S A	S A	S A	S A	
BLWE06		S A	S A	S A	S A	S A	S A	S A	S A	
BLWE06		S A	S A	S A	S A	S A	S A	S A	S A	
BLWE06		S A	S A	S A	S A	S A	S A	S A	S A	
GIPE03		S A	S A	S A	S A	S A	S A	S A	S A	
GIPE03		S A	S A	S A	S A	S A	S A	S A	S A	
GIPE03		S A	S A	S A	S A	S A	S A	S A	S A	
MISE12		S A	S A	S A	S A	S A	S A	S A	S A	

MISE12		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
MISE12		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
MOGE12		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
MOGE12		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
MOGE12		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PAGO10		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PAGO10		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PAGO10		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PELA09		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PELA09		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PELA09		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PELI02		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PELI02		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
PELI02		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RALA09		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RALA09		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RALA09		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMA04		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMA04		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMA04		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMA06		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMA06		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMA06		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMO02		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMO02		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
RAMO02		S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A

ROLO05		S	A													
ROLO05		S	A													
ROLO05		S	A													

APPENDIX F:
Quarry schematic

VT Quarry Layout



APPENDIX G:

Post-intervention survey and focus group questions

FOCUS GROUP QUESTIONS

- 1. What did you like (if anything) about the safety program?**

- 2. What did you not like (if anything) about this safety program?**

- 3. Did the safety program influence your work practices?**

- 4. How could we improve the safety program?**

- 5. Why were the % safe scores higher in the Breaking Room than in the Cutting Room?**

- 6. Should this program be continued? How?**

APPENDIX H:
CURRICULUM VITA

Curriculum Vita

Jeffrey Scott Hickman

E-Mail: jehickma@vt.edu

Present Address:

297 New Kent Road
Blacksburg, VA
24060
Phone: (540) 818-4466

Business Address:

5100 Derring Hall
Blacksburg, VA
24060-0436
Phone: (540) 231-8145

Education

- Currently Pursuing M.S.- Clinical Psychology. Specialization Area: Clinical Health Psychology. Virginia Polytechnic Institute and State University, Blacksburg, VA. Cumulative GPA: 3.21/4.0
- December 1997 B.S. – Psychology. University of Florida, Gainesville, Florida. Cumulative GPA: 3.35/4.0
- June 1993 High School Diploma. J. P. Taravella High School, Coral Springs, Florida. Cumulative GPA: 3.57/4.0

Honors and Awards Received

- Virginia Tech Graduate Student of the Month for the month of November, 2001
- Graduate School Research Award (\$300) for Thesis Research (2001)
- Virginia Tech Graduate Student of the Month (November, 2001)
- SWABA Legibility Award (2000), ABA Washington DC
- Deans List (96-97), *University of Florida*

Research Experience

Graduate Research Assistant. (12/2001-present). Center for Applied Behavior Systems, Virginia Tech. Assisted the principal investigator in writing an NIH grant to assess various self-management techniques to increase safety-related driving practices with professional drivers. Conducted research increasing safety-related work behaviors using self-management techniques at two industrial settings: Virginia Tech Quarry and D.M Bowman (short-haul trucking). Conducting preliminary research assessing the perceptions and attitudes of airline travelers regarding airline and airport safety. Additionally, conducting field-research on compliance rates using two different solicitation approaches (reciprocity & three-term contingency). Duties included training and supervising undergraduate research assistants in data collection, data entry, construction of database, and data analysis. Held weekly meetings on project progress, proper

implementation of new treatment interventions, and scheduling of undergraduate research assistants.

Supervisor: *E. Scott Geller, Ph.D.*

Clinical Externship. (5/2001-Present). Health Management Consultants of Virginia, Blacksburg, VA. Research assistant to the principal investigator in several NIH-funded research grants, including: *MedPal*-a medication compliance device with a decision information website for cardiac rehabilitation patients, and *Exerlink*-accelerometer research for objective data on cardiac patients activity levels. Duties included answering phones, preparing news flashes for the website, data analysis, running focus groups, time analyses, participating in weekly progress meetings, and assisted the principal investigator in writing a SBIR to NHLBI for research assessing the effects on an Internet-based treatment for depressed cardiac rehabilitation clients.

Supervisor: *Doug Southard, Ph. D.*

Graduate Research Assistant. (8/2001-12/2001). Center for Applied Behavior Systems, Virginia Tech. Conducted research increasing safety-related work behaviors using self-management techniques at two industrial settings: Virginia Tech Quarry and D.M Bowman (short-haul trucking). Also conducting preliminary research assessing the perceptions and attitudes of airline travelers regarding airline and airport safety. Duties included training and supervising undergraduate research assistants in data collection, data entry, construction of database, and data analysis. Held weekly meetings on project progress, proper implementation of new treatment interventions, scheduling of undergraduate research assistants. Assisting the principal investigator in writing a NIOSH-funded grant resubmission to use safety self-management techniques to increase safe driving practices for short-haul truck drivers and pizza delivery drivers using innovative computer technology.

Supervisor: *E. Scott Geller, Ph.D.*

Graduate Research Assistant. (8/2000-5/2001). Center for Applied Behavior Systems, Virginia Tech. Project Co-Manager for a Mine Safety and Health Administration grant for the implementation of behavior-based safety procedures in mining operations. Assisted the principal investigator in writing the final report to NIOSH. Duties included training and supervising undergraduate research assistants in data collection, data entry, formulation of a database, and data analysis. Held weekly meetings on project progress, proper implementation of new treatment interventions, and scheduling of undergraduate research assistants.

Supervisor: *E. Scott Geller, Ph.D.*

Graduate Research Assistant. (8/99-5/2000). Center for Applied Behavior Systems, Virginia Tech. Graduate assistant to the principal investigator for a Mine Safety and Health Administration grant for the implementation of behavior-based safety procedures in mining operations. Duties included training and supervising undergraduate research assistants in data collection, data entry, formulation of a database, and data analysis. Held weekly meetings on project progress, and proper implementation of new treatment interventions, scheduling of undergraduate research assistants.

Supervisor: *E. Scott Geller, Ph.D.*

Graduate Research Assistant. (5/98 to 5/99). *Self-Injurious Behavior Lab (Tachachale), University of Florida.* One of several principal therapists at a state run facility for individuals with mental retardation. Implemented behavioral interventions for a myriad of problem behaviors (self-injurious behavior, communication skills, pica, appropriate play skills, etc). Supervised undergraduates in data collection, graphing, and interpretation of data. Conducted weekly presentations on client progress and treatment options.

Supervisor: *B. A. Iwata, Ph.D.*

Undergraduate Research Assistant. (9/97 to 12/97). *Self-Injurious Behavior Lab (Tacachale), University of Florida.* Duties included reading required literature, data collection, data observation, graphing, scoring, and working with hand held computers.

Supervisor: *B. A. Iwata, Ph.D.*

Undergraduate Research Assistant. (5/97 to 8/97). *Shands Hospital, University of Florida.* Investigated the social functioning of children with cancer. Duties included conducting interviews with parents and children, scoring data, computer entries, and handing out questionnaires.

Supervisor: *W. Kubar, Ph.D.*

Undergraduate Research Assistant. (4/97 to 8/97). *The Family Institute, Gainesville, Florida.* Assisted in the writing process for a text chapter on counseling Latino/a families. Duties included reading pertinent literature on socio-political, acculturation, dementia, therapy, and counseling theories pertaining to Hispanics.

Supervisor: *A. Nazario, Ph.D.*

Clinical Experience

Adult Assessment Team (8/2001-Present). *Psychological Services Center, Blacksburg, Virginia.* Conducted six psycho-educational assessments on adult clients to rule out Attention-Deficit/Hyperactivity Disorder, Learning Disorders, memory deficits, and personality profiles. Assessment instruments included: Conners' Adult ADHD Rating Scale-Other (CAARS-O), Conners' Adult ADHD Rating Scale-Self (CAARS-S), Conner's Continuous Performance Test-II (CPT-II), Millon Clinical Multiaxial Inventory, 3rd Edition (MCMI-III), Minnesota Multiphasic Personality Inventory, 2nd Edition (MMPI-II), Paced Auditory Serial Attention Test (PASAT), Retrospective Structured Clinical Interview (RSCI), Symptom Checklist 90, Revised (SCL-90-R), Wender Parents' Rating Scale (WPRS), Wender Utah Rating Scale (WURS), Weschler Adult Intelligence Scale, 3rd Edition (WAIS-III), Weschler Memory Scale, 3rd Edition (WMS-III), and Woodcock-Johnson Achievement Test, 3rd Edition (WJ-III).

2nd Year Practicum. (8/2000 to 3/2001). *Psychological services Center, Blacksburg, Virginia.* Team discussion and observation of clinical services to children, adults, and families with a variety of clinical problems. Performed direct clinical service sessions with seven adults, one adolescent, one child, and one toddler.

Supervisor: Lee Cooper, Ph.D., Director

1st Year Practicum. (8/99 to 3/2000). *Psychological Services Center, Blacksburg, Virginia.* Team discussion and observation of clinical services to children, adults, and families with a variety of clinical problems. Performed direct clinical service sessions with two adults and facilitated group discussions with two other therapist's for a group of anti-social teens.

Supervisor: Richard Eisler, Ph.D.

Presentations

Hickman, J. S., Geller, E. S., Cincotta, A. L., Rosti, S. L., & Grandin, D. (2002, May). *Safety Self-Management in Mining Operations.* Paper to be presented at the 80th Annual Meeting of the Virginia Academy of Sciences.

Rosti, S. L., Hickman, J. S., & Geller, E. S. (2002, May). *Are we motivated by consequences or reciprocity?* Paper to be presented at the 80th Annual Meeting of the Virginia Academy of Sciences.

Hickman, J. S. (2002, February). *Safety Self-Management with Short-Haul Truck Drivers (Feedback).* Training and education materials presented to D. M. Bowman, Inc short-haul truck drivers, Frederick, MD.

Hickman, J. S. (2002, February). *Safety Self-Management in Mining Operations (Feedback).* Training and education materials presented to Virginia Tech Quarry employees at the Health and Safety Building, Virginia Tech.

Hickman, J. S. (2002, January). *Safety Self-Management with Short-Haul Truck Drivers (Feedforward).* Training and education materials presented to D. M. Bowman, Inc short-haul truck drivers, Frederick, MD.

Hickman, J. S. (2002, January). *Safety Self-Management in Mining Operations (Feedforward).* Thesis training and education materials presented to Virginia Tech Quarry employees at the Health and Safety Building, Virginia Tech.

Hickman, J. S. (2002, January). *Safety Self-Management in Mining Operations (Feedback).* Thesis training and education materials presented to Virginia Tech Quarry employees at the Health and Safety Building, Virginia Tech.

Hickman, J. S., Glindemann, K., & Geller, E. S. (2001, May). *Measuring the Propensity to Participate in Behavioral Safety: A Culture Assessment at Six Mining Operations.* Paper presented at the annual Association for Behavior Analysis in New Orleans, Louisiana.

Hickman, J., Click-Keeney, R. D., & Geller, E. S. (2001, April). *Behavior-Based Safety in the Mines: Applications, Dilemmas, and Future Directions.* Paper presented at the annual Eastern Psychological Association in Washington, D.C.

Hickman, J. S. & Click-Keeney, R. D. (2000 August). *Behavior-based safety in mining operations.* Paper presented at the annual Mine Health and Safety Conference, Roanoke, VA.

Hickman, J. S., Click-Keeney, R. D., Geller, E. S., & Pettinger, C. B. (2000, March). *The "Airline Lifesaver": A 15-year evaluation of a large-scale awareness intervention.* Paper presented at the annual program of the Southeastern Psychological Association, New Orleans, Louisiana.

Hickman, J. S., Click-Keeney, R. D., Williams, J., & Geller, E. S. (2000, May). *Using behavior observation and feedback process in mining to improve safety.* Paper presented at the Association for Behavior Analysis, Washington, D.C.

Hickman, J. S., Click-Keeney, R. D., Geller, E. S., & Pettinger, C. B. (2000 April). *Evaluating a large-scale awareness program.* Paper presented at the semi-annual Virginia Psychological Association, Tysons Corner, VA.

Click-Keeney, R. D., Hickman, J. S., Pettinger, C. B., Ford, K., Halpin, C., & Geller, E. S. (2000, May). *Behavior-based safety: Comparing individual versus group feedback in mining operations*. Poster presented at the Association for Behavior Analysis, Washington, D.C.

Wallace, M. D., Iwata, B. A., Hanley, G. P., & Hickman, J. S. (2000 May). *The effects of dense and lean schedules of noncontingent reinforcement (NCR) on problem behavior*. Paper presented at the Association for Behavior Analysis, Washington, D.C.

Thompson, R. H., Iwata, B. A., Wallace, M. D., Conners, J., Roscoe, E. M., & Hickman, J.S. (1999, May). *Response acquisition under indirect and direct contingencies of reinforcement*. Paper presented at the Association for Behavior Analysis, Chicago, IL.

Wallace, M. D., Iwata, B. A., Hickman, J. S., & Thompson, R. H. (1999, May). *Transition of satiation from extinction during non-contingent reinforcement*. Paper presented at the Association for Behavior Analysis, Chicago, IL.

Publications

Geller, E. S., Hickman, J. S., & Click, R. D. (2000). Addressing the human aspects of mining safety: From behaviors to attitudes to culture change. *Thirty-First Annual Institute on Mining Health, Safety, and Research*, p. 81-91.

Teaching Experience

Graduate Teaching Assistant. (1/2001-5/2001). *Psychology Department, Virginia Tech.* Teaching Assistant for two undergraduate classes: child psychopathology and child development. Each class had over 40 students enrolled and met three-times a week. Duties include lecture preparation, grading essays, holding office hours, quiz creation, test creation, test and quiz grading, proctoring exams, and maintaining class database for grades.

Supervisor: *M.A. Bell, Ph.D., & A. Scarpa-Friedman, Ph.D.*

Graduate Teaching Assistant. (8/99 to 5/00). *Psychology Department, Virginia Tech.* Taught two recitation (lab) companion classes to the Introductory Psychology course. Each class had over 30 students enrolled and met once a week. Duties include lecture preparation, discussion, debate, holding office hours, quiz creation and grading, essay assignment and grading, and proctoring exams.

Supervisor: *J.W.Finney, Ph.D.*

Service

Professional Memberships and Honor Societies:

- Association for Behavior Analysis (*student member since 1997*)
- South Eastern Psychological Association (*student member since 1999*)
- Virginia Psychological Association (*student member since 2/2000*)
- Eastern Psychological Association (*student member since 1/2001*)

Campus Involvement:

- Pi Lambda Phi Fraternity (*1993 to present*). New Member educator (*1996*). Member of Rituals, New Members, and Rush committee (*1994 to 1997*).
- University of Florida Intramural Sports (*1993-1997*). Participated in flag football, softball, soccer, and track and field.

Community Service and Involvement:

- YMCA and City of Gainesville Youth Soccer Coach (*1994*). Assisted in coaching children for youth soccer.

Grants and Scholarships Received

- Graduate School Research Development Award (\$300) for Thesis Research (2001)
- Graduate Research Assistantship from MSHA (15 hour stipend, Summer 2000-2001)
- Graduate Research Assistantship from MSHA (20 hour stipend, 1999-2000)
- Florida Academic Scholarship Award (\$1000 to \$3,000 yearly, 1993-1997)

Professional Conferences and Workshops Attended

- Association for Behavior Analysis- New Orleans, LA (5/2001)
- Eastern Psychological Association- Washington, D.C. (4/2001)
- Mine Health and Safety Conference- Roanoke, VA (8/00)
- Association for Behavior Analysis- Washington, D.C. (5/00)
- Virginia Psychological Association- Tysons Corner, VA (4/00)
- Southeastern Psychological Association- New Orleans, LA (3/00)
- Association for Behavior Analysis Conference- Orlando Florida (5/98)
- Florida Association for Behavior Analysis- Daytona, Florida (1/98)

Graduate Coursework

- Statistics I
- Research Methods
- Psychopathology
- Practicum (1st year) in Psychotherapy
- Proseminar in Behavior Analysis
- Principals of Operant Conditioning
- Child Psychopathology
- Personality/Intellectual assessment
- Statistics II
- Social Psychology
- Behavior Management in Large-Scale Systems
- Practicum (2nd year) in Psychotherapy
- Personality Processes

- Biological Bases of Behavior
- Proseminar in Learning
- Principles of Ethics in Clinical Psychology
- Advanced Psychotherapy