Effects of Employee Involvement on Behavior-Based Safety[1.]

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Abstract

A behavior-based safety (BBS) process was introduced at a southeastern manufacturing facility. Employee involvement (i.e., choice vs. assigned) was manipulated during BBS education/training and during implementation of a BBS process. During BBS education/training sessions, employees in the Choice condition (first shift, n=230) were asked for suggestions concerning their company's safety process, with employees in the Assigned condition (second & third shifts, n=246) having no input. The involvement manipulation continued by having the first shift safety facilitators (n=8) design and make all choices concerning the BBS process, while second shift facilitators (n=6) were Assigned the specifics of the safety process. During the BB education/training sessions, there were no group differences regarding information retention, satisfaction, or perceived involvement. However, over a nine-week period, safety facilitators in the Choice condition participated significantly more in a BBS observation/feedback intervention than those in the Assigned condition.

Introduction

Throughout a one-year period of BBS interventions, the company's lost-time injuries decreased from 10.9 to 1.5 per month with an estimated $200,000 savings in workers' compensation costs. Implications for designing BBS interventions, increasing employee participation, and ultimately, institutionalizing a BBS process are discussed.

The leading cause of death for people under the age of 38 is not heart disease nor cancer, but something as common as injuries. Injuries kill more than 93,000 Americans and require an estimated $478 billion dollars in total costs each year (National Safety Council, 1998; U. S. Bureau of Labor Statistics, 1997). Due to the frequency and severity of injuries, the U.S. Department of Health and Human Services (1990) has identified injury prevention as a priority for attaining the goals. Every day, an estimated 10,000 to 36,000 U.S. employees are injured and 14 are killed. Moreover, an estimated 5,000 to 11,000 workers die and 2.5 to 11.3 million employees suffer non-fatal injuries. More specifically, employees in manufacturing facilities who sustain non-fatal injuries have an average of 101 lost workdays per 100 employees each year (Leigh, 1995; Miller, 1997; Nation Institute for Occupational Safety and Health, 1998; National Safety Council, 1998; U. S. Bureau of Labor Statistics, 1997). Thus, unintentional injury represents a serious public health concern, and theory-driven injury prevention research is needed to improve the effectiveness of current safety and health interventions.

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From the early 1900s to the present time, employers and safety practitioners have adopted a safety philosophy represented by three words beginning with the letter "E" – engineering, education, and enforcement (Geller, 1996; Guastello 1993; Heinrich, Petersen, & Roos, 1980; Petersen, 1996; Wilde, 1998). To make a difference in the health and safety of employees, the three Es of safety focus on: 1) developing engineering strategies to make tools and equipment safer to use; 2) educating and training employees regarding engineering safe guards, environmental hazards, policies and procedures; and 3) enforcing the safety-related policies and procedures related to operating equipment, wearing proper personal protective equipment, and handling specific hazardous substances.

Although the three E's have had a dramatic impact on the safety of employees, recent research has suggested that the most effective workplace safety interventions involve the workers in the design and implementation of a organization's safety process, as opposed to the more traditional "top-down" safety programs (Daniels, 1989; Geller, 1996, 1998c, d; McSween, 1995; Petersen, 1996). Safety processes grounded in the principles of behavioral science facilitate "bottom-up" employee involvement and perceptions of personal control.

Applied Behavior Analysis

Applied behavior analysis has made substantial contributions to the domain of health promotion and injury control by researching the determinants of at-risk behaviors, directing the development of effective behavior change interventions, and applying these interventions in a variety of domains like behavioral medicine (Cataldo & Coates, 1986), safety performance (Geller, 1996; Petersen, 1996), health psychology (Elder, Geller, Hovell, & Mayer, 1994; Winett, King, & Altman, 1989), traffic safety (Geller, 1998a), environmental protection (Geller, Winett, & Everett, 1982), and child safety (Roberts, Fanurik, & Layfield, 1987).

Behavior-based approaches to injury control have a number of advantages over other approaches, including: a) they can be administered without extensive professional training; b) they can reach people in the setting where a problem occurs (e.g., community, school, workplace); and c) leaders in various settings can be taught the behavioral techniques most likely to work under relevant circumstances (Baer, Wolf, & Risley, 1968; Daniels, 1989; Geller, 1996, 1998b,d). Research has also shown this approach to be cost effective, primarily because BBS techniques are straightforward and relatively easy to administer, and because intervention progress can be readily assessed by indigenous personnel (e.g., Daniels, 1989; Geller, 1996; Geller et al., 1982; Sulzer-Azaroff & De Santamaria, 1980).

The application of applied behavior analysis principles for occupational safety and health is commonly referred to as behavior-based safety (BBS). Over the past 20 years, BBS has been used successfully in the prevention of occupational injuries (e.g., Alavosius &

Sulzer-Azaroff, 1986; Geller & Hahn, 1984; Komaki, Barwick, & Scott, 1978; Krause, Hidley, & Hodson, 1996; Reber & Wallin, 1983, 1984; Smith, Anger, & Ulsan, 1978). In fact, Guastello (1993) found by systematically reviewing 53 occupational safety and health studies since 1977, that BBS had the highest average reduction of injury rate (59.6%). Most of these studies, however, were simply demonstrations of techniques that had already been researched in other settings. Researchers in BBS have not systematically evaluated different implementation procedures and therefore can provide limited guidance for improving a BBS protocol.

Research in the area of BBS needs to ask and answer questions regarding the design of more effective and longer-term intervention processes (National Institute for Occupational Safety and Health, 1998). This was the prime purpose of the research reported here. Specifically, we studied the extent that employee involvement increases the impact of BBS training and implementation. We hypothesized that a participative approach to education and training would be more effective than a standard lecture format, and that involving employees in the design and implementation of a BBS process would lead to greater impact than following the traditional strategy of top-down safety assignments.

Method

Subjects and Setting

Subjects were 476 hourly and salary employees at an engine-bearing manufacturing plant in southwest Virginia. The population of employees ranged in age from 19 to 63 years ($\underline{M}$ = 42), and employee tenure at the facility ranged from six months to more than 25 years ($\underline{M}$ = 16). The proportion of hourly to salary workers was approximately five to one, and the workforce and hours worked were stable throughout the course of the study.

Procedure

The BBS process began by training volunteer safety facilitators from representative work areas on first shift (n=8) and second shift (n=6) in the basic principles and procedures of this approach. Topics included: a) defining target behaviors, b) developing checklists to record occurrences of target behaviors, c) designing interventions to improve safety-related behaviors, d) charting progress in a time-series format, and e) giving effective behavioral feedback. Following two intensive eight-hour education/training sessions for the volunteer safety facilitators, the remaining employees across three shifts received a four-hour version of BBS education/training.

Education/Training Manipulation

The format and style of the education/training sessions were manipulated to investigate the impact of employee participation during BBS training. The materials for all sessions, however, were held constant. Four research associates served as safety trainers. Each was experienced at leading safety workshops. Randomized pairs of trainers conducted all the BBS education/training sessions. The material covered in plantwide BBS workshops paralleled that provided to the safety facilitators, but in a four-hour version.

Choice condition. Throughout the course of the two eight-hour safety facilitator and four-hour plant wide education/training sessions, the safety trainers in the Choice condition asked questions of participants, requested relevant stories, and facilitated discussions and interpersonal involvement though group exercises (n=230 on Shift 1). All sessions occurred during the regular shift of the scheduled employees, and concluded with a written test of key safety concepts, principles, and procedures.

Assigned condition. The Assigned education/training sessions were identical to the Choice sessions except the safety trainers in the Assigned condition presented the safety material in a lecture format without asking questions or facilitating input from participants (n=246 on Shifts 2 and 3). The four-hour education/training sessions were conducted for 12 Choice groups and 14 Assigned groups, with an average of 19 employees attending the workshops.

Evaluation procedures. To assess the impact of the two training approaches, three variables were measured: the amount of verbal participation, participants' reported satisfaction with the training, and the participants' retention of key information presented. To assess verbal participation, trained research assistants attended all sessions across both conditions and independently recorded the frequency of all verbal behaviors from the employees that were directed to the trainers. The verbal behaviors included questions asked, questions answered, and reactive statements. These observations were recorded unobtrusively on a data collection sheet attached to a notebook, giving the impression the observers were taking notes. An assessment of employee engagement was needed to assess involvement, so questions or comments irrelevant to the training materials or directed to individuals other than the trainer presenting information were not recorded (e.g., "when are the breaks" or personal comments made to fellow coworkers). Interobserver agreement was assessed on a session-by-session basis by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Across all education/training sessions, the research assistants agreed on over 90% of their observations. Following the education/training sessions, employees received a questionnaire assessing their satisfaction, perceptions of participation, and knowledge retention. The names of the participants did not appear on any test document or session evaluation.

BBS Implementation

Many involvement manipulations were made to give Shift 1 facilitators (n=8) opportunities to make key decisions in the implementation of their BBS process. Specifically, during separate Shift 1 safety meetings, Shift 1 safety facilitators selected: a) the initial safety-related behavior (hearing protection) to be observed plantwide, b) the design of the checklist used to make observations of the target behavior, c) schedules for behavioral observations by facilitators, d) the target number of behavioral observations per week, e) the design and location of group feedback charts displaying on-going measures of plantwide hearing protection use, f) the protocol for a safety slogan contest, and g) the design and color of special safety shirts distributed plantwide. The choices made by Shift 1 safety facilitators were assigned to Shift 2 safety facilitators (n=6), in that both shifts implemented the same process customized by Shift 1. Table 1 outlines the involvement manipulations during the education/training sessions, and during the implementation of the BBS process.

CHOICE CONDITION	ASSIGNED CONDITION
(Shift 1, n=230) Education/Training	(Shifts 2&3, n=246)
Trainers in the Choice condition: 1) asked employees questions, 2) asked employees opinions, 3) encouraged discussion, 4) conducted group exercises, and 5) asked for safety process suggestions.	Trainers in the Assigned condition: 1) did not ask questions and only lectured, 2) did not solicit employee opinions, 3) lectured without discussion, 4) gave examples of exercises completed by Shift 1 employees, and 5) did not prompt employees for safety process suggestions.
(Shift 1, n=8) Implementation	(Shift 2, n=6)
Facilitators in the Choice condition: 1) chose initial target behavior, 2) designed checklist, 3) decided observation schedule, 4) chose target number of observations, 5) chose design and location of data charts, 6) designed safety slogan contest, and 7) designed safety shirts.	Facilitators in the Assigned condition: 1) were told target behavior to observe, 2) were given checklists for observations, 3) were told how often to observe, 4) were told how many observations were required per week, 5) were given blank data charts and told where to post them, 6) had no input in contest, and 7) had no input on shirts.

For nine weeks, safety facilitators (n=14) made a total of 5466 behavioral observations of the hearing protection use (i.e., proper placement of earplugs in ears or earmuff over ears) of employees on Shifts 1 (n=230) and 2 (n=210). On each shift, one safety facilitator was responsible for collecting completed observation cards. These data were collected two times a month at facilitator meetings that were also attended by the first and/or second author. Following a three-week baseline period, hearing protection data were graphed and posted on a safety bulletin board located at the main entrance to the manufacturing areas.

Facilitator involvement was assessed by the number of behavioral observations of hearing protection use conducted per shift.

Results

Participation in Training

Analysis of variance (ANOVA) was used to evaluate differences in the number of verbal responses occurring per shift, with Shift 1 in the Choice condition and Shifts 2 and 3 receiving the Assigned condition. A one-way ANOVA on verbal behaviors for training format (Choice vs. Assigned) indicated that participants in the Choice condition exhibited significantly more verbal behaviors than participants in the Assigned condition, F (2, 395) **=** 38.9, $p < .001$. Shift means and standard deviations are presented in Table 2.

Dependent Measure	Shift 1 (n=168) (Choice)	Shift 2 (n=119) (Assigned)	Shift 3 (n=111) (Assigned)
Number of Answers (per participant)	M = 4.02 * SD = 6.06	M = 0.34 SD = 0.85	M = 0.38 SD = 0.93
Number of Comments (per participant)	M = 2.34 * SD = 3.54	M = 0.67 SD = 1.39	M = 0.73 SD = 1.54
Number of Questions (per participant)	M = 0.14 SD = 0.50	M = 0.08 SD = 0.30	M = 0.08 SD = 0.36
Total Verbal Behaviors (per session)	M = 6.50 * SD = 8.80	M = 1.09 SD = 1.97	M = 1.19 SD = 2.44
Percent Correct on Test	M = 66.7% SD = 20.47	M = 68.9% SD = 18.20	M = 66.5% SD = 17.90
Perceptions of Involvement (5-point Likert scale)	M = 2.56 SD = 1.08	M = 2.42 SD = 0.89	M = 2.30 SD = 0.91
Satisfaction of Training (5-point Likert scale)	M = 3.44 * SD = 1.20	M = 3.20 SD = 1.37	M = 2.95 SD = 1.45

Table 2: Mean and standard deviation of measures taken to evaluate impact of the Choice vs. Assigned condition during education/training M = mean, SD = standard deviation, * $p < .05$

Analyses were also conducted on each type of verbal response: questions answered, reactive comments, and questions asked. A one-way ANOVA of questions answered per Shift (Shift 1 vs. Shift 2 vs. Shift 3) indicated that participants in the Choice condition answered significantly more questions than participants in the Assigned condition, F (2, 395)= 40.6**,** $p < .001$. The analysis of reactive comments indicated that participants in the Choice condition made significantly more comments than participants in the Assigned condition, F (2, 395) = 19.1, $p < .001$. The ANOVA for questions asked indicated no significant difference across shifts, $p > .05$.

The post-session questionnaires included: a) an 18-item knowledge test, b) a 5-item measure of perceived involvement, and c) a one-item measure of satisfaction with the training. A one-way ANOVAs by Shift (Shift 1 vs. Shift 2 vs. Shift 3) indicated no significant differences between the knowledge scores of participants in the Choice vs. Assigned condition, nor the participants' perceptions of involvement, $p > .05$. The ANOVA of participants' self-reported satisfaction with the training process revealed that participants in the Choice condition (i.e., Shift 1) were more satisfied with the training process than Shift 3 participants in the Assigned condition, $F(2, 438) = 5.04$, $p < .05$. However, the satisfaction ratings of Shift 2 participants in the Assigned condition were not significantly different from the Shift 1 participants in the Choice condition, $p > .05$.

Behavioral Observations

Over a nine-week observation and feedback period, Shift 1 facilitators (n = 8) made significantly more observations per week than Shift 2 facilitators (n = 6), $t(16) = 3.05$, $p < .05$. An observation was defined as the single occurrence of recording hearing protection as safe versus at-risk on a critical behavior checklist. Additionally, Shift 1 facilitators conducted significantly more observations per person each week than the Shift 2 facilitators, $t(16) = 3.05$, $p < .05$. Table 3 contains the means and standard deviations associated with these analyses.

Dependent Measure	Shift 1 Facilitators (n=8) (Choice)	Shift 2 Facilitators (n=6) (Assigned)
Observations per Week	M = 422.9 * SD = 135.7	M = 245.0 SD = 110.2
Observations per Facilitator	M = 10.6 * SD = 3.4	M = 6.1 SD = 2.8
Percentage of Shift	M = 36.8% * SD = 11.8%	M = 23.3% SD = 10.5%

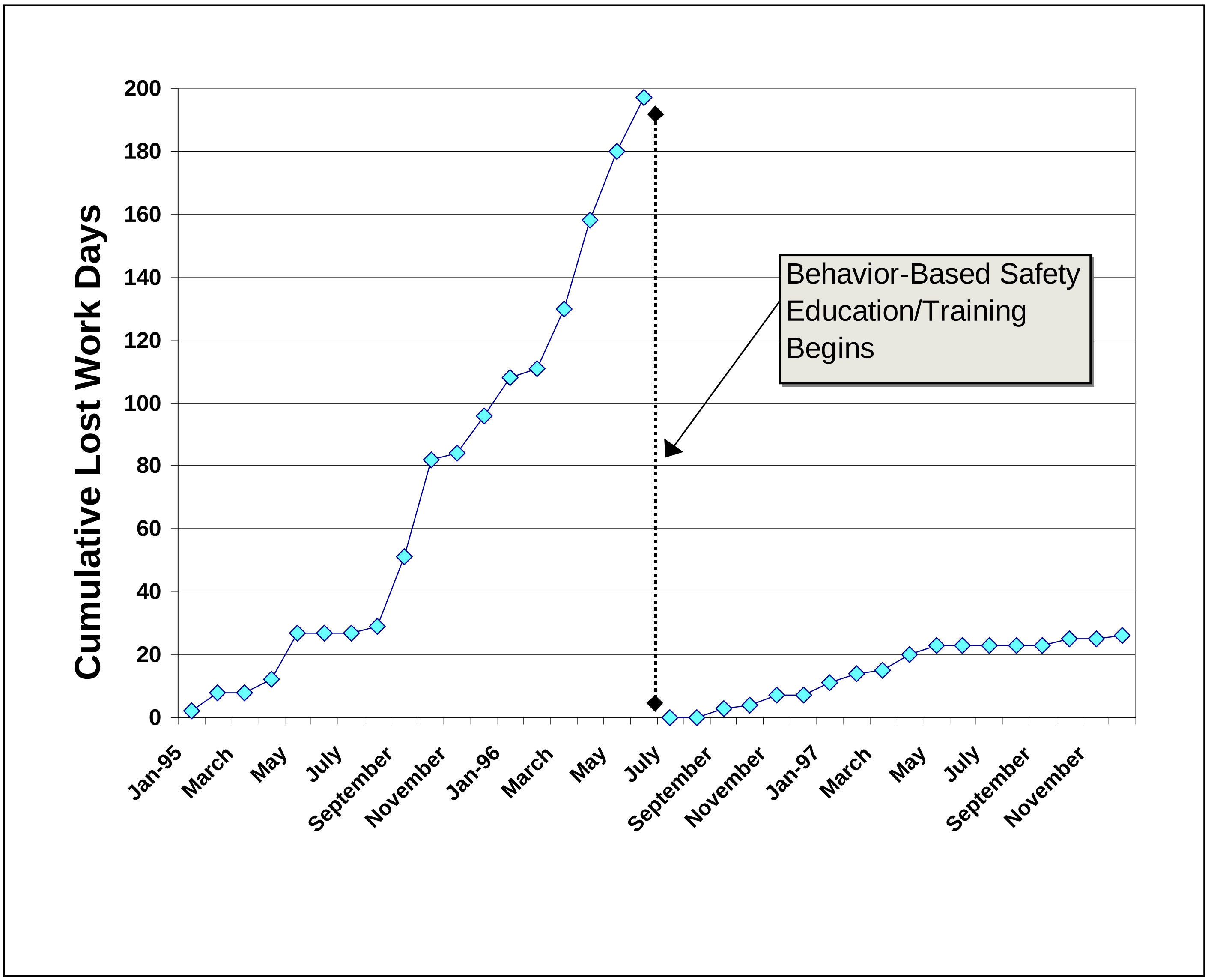
Table 3: Mean number of observations by facilitators during the nine-week intervention period M = mean, SD = standard deviation, * p < .05

Plantwide Hearing Protection

Following a three-week baseline period, hearing protection use observed by safety facilitators was graphed separately and posted for Shifts 1 and 2 (intervention phase). During the baseline period, there were no differences between Shift 1 safe hearing protection use (82%, n=618) verses Shift 2 (84%, n=758). Following the posting of employee hearing protection use, a significant improvement was only observed on Shift 1 [χ^2 (2, n=5466) = 6.00, $p < .05$]. When employee observations of the average hearing protection use by week was compared with the averages observed by the research assistants, no significant differences were found between groups ($p > .05$).

Lost Workdays

Figure 1 depicts a cumulative record of this organization's lost workdays for 18 months prior to and 18 months following the BBS process. The figure shows a marked decrease in lost days due to injuries following the introduction of BBS education/training, observation/feedback for hearing protection, and several additional intervention processes. A mean of 10.9 lost days per month occurred prior to BB safety; whereas after the intervention, a mean of 1.5 days per month were lost due to injury.



Discussion

Our manipulation of involvement during the education/training sessions was successful; the Choice groups answered significantly more questions, asked significantly more questions, and made significantly more comments. However, our evaluation of training impact did not support the hypothesis that employees would rate participative training as more effective and appreciated than nonparticipative training. The lack of significant group differences for information retention, satisfaction, and perceived involvement suggest that: a) involvement differences may not be reflected entirely by verbal behavior, b) the nature of the training material itself may have involved the workers cognitively if not verbally, or c) a participation format might not be more effective than a lecture approach, at least with regard to information retention and personal satisfaction. Furthermore, as described below, our data indicate that measures taken immediately following training may not be indicative of successful implementation of a behavioral safety process.

With regard to implementation, the current research does suggest it is advantageous to facilitate employee ownership and involvement when *instituting* a BBS process. This was evident by the differential amount of behavioral observations performed by safety facilitators in the Choice versus Assigned condition. Although facilitators in the Choice condition did not report feeling more involved, nor did they demonstrate greater knowledge of the BBS information presented, they did conduct significantly more interpersonal observations. Thus, the benefit of the involvement manipulation was manifested during the operation of a BBS observation and feedback process.

A review of the research literature revealed convincing evidence that behavioral approaches to occupational safety can be extremely effective at reducing at-risk behavior and workplace injuries. A key ingredient of most effective BBS interventions has been a behavioral observation and feedback process (cf. Geller, 1996, 1998d). In other words, participants need a mechanism for learning what to do differently in order to prevent the possibility of personal injury. Little is known, however, about the best way to design and deliver a BBS observation and feedback process, nor has there been any systematic study of the role of training participation on the subsequent application of BBS.

This study manipulated level of employee involvement during BBS education/training and identified at least one factor that may increase the impact of a BBS process. Specifically, when employees are given the opportunity to make key choices in the development and implementation of the safety process, they will contribute more to the process. This is as predicted by the social psychological principle of consistency (Cialdini, 1993). In other words, research in social psychology has shown that people have a desire to maintain a consistency between their thoughts and behaviors (cf. Festinger, 1957). Consistency is a valued commodity in our society (Cialdini, 1993), and people have been previously reinforced for maintaining a consistency between what they say and what they do (Rogers-Warren & Baer, 1976).

When workers are responsible for selecting a safety behavior to target, deciding how to observe and record that behavior, and planning how to intervene and chart progress, they are more likely to engage in the behaviors they have selected and are asking others to perform. Additionally, according to self-efficacy theory, people given choice in an improvement process will select solutions they perceive to be within their realm of capabilities (Bandura, 1997). Thus, self-efficacy and consistency theories likely contributed to the greater number of behavioral observation made by safety facilitators in the Choice than Assigned condition.

Ludwig and Geller (1997) also found special benefits of a Choice over an Assigned intervention in a pizza delivery setting. More specifically, pizza deliverers who participated in a goal-setting intervention to increase their complete intersection stops also increased their use of safety belts and turn signals (nontargeted behaviors) during the intervention phase. Conversely, employees assigned the same goal for intersection stops, increased that target behavior, but actually decreased their use of safety belts and turn signals during the assigned goal intervention phase for intersection stops. Consistent with the findings of Ludwig and Geller (1997), it can be speculated that the intervention targeting hearing protection in the current research generalized to other safety-related behaviors and thus contributed to the marked reduction in workplace injuries.

In the current research, the reduction in lost-time injuries plantwide strongly suggests the BBS process did much more than increase the use of hearing-protection. The plantwide safety training and the regular meetings to discuss the hearing protection data probably increased awareness of general safety concerns throughout the facility. The BBS interventions certainly gave the employees the impression that management has increased the priority level of safety. Perceptions of management support, combined with success at performing behavioral observations, may have increased employees' general efficacy regarding their safety performance.

Thus, consistent with Bandura (1997), it may be claimed that as the workers experienced success making observations on a single target behavior, they stretched the boundaries of their behavioral routines and incorporated the BBS principles in other safety-related circumstances. For example, after the employee safety education/training sessions and the increased focus on using hearing protection, all employees were urged to participate in a plantwide safety slogan contest with the winning slogan ("Bearings in Mind: Safety First!") being awarded a $50 gift certificate in a public celebration. Safety facilitators printed the slogan on a 3-foot by 8-foot banner and displayed it at the entrance to the manufacturing areas.

In addition, throughout the 18 months following BBS training, employees on both Shifts 1 and 2 performed specific interventions within their work areas that targeted various behaviors they considered critical for improving safety on their jobs. With each intervention, the work area met to define the target behavior, develop observation checklists and procedures, and decide how to intervene and test the intervention for impact. During education/training this BBS continuous improvement process was referred to as DO IT for define, observe, intervene, and test (Geller, 1996). That the impact of individual area interventions can generalize plantwide was reported by Saarela

(1990) who showed the effects of feedback to small groups for behavior related to safety also led to improved housekeeping and a significant reduction in injuries among employees at an industrial shipyard.

It has been suggested that many occupational injuries go unreported (Leigh, 1995; Miller, 1997; Weddle, 1996; Wilson, 1985). Therefore, using a safety metric that is difficult to hide or cover up, such as lost-time injuries, probably provides a more accurate picture of the impact of a safety improvement process than a record of minor or OSHA recordables. As such, following the introduction of BBS there was a dramatic decrease in lost workdays due to injury (from 197 to 26). This prominent reduction in lost workdays was reported by the organization to save approximately $200,000 in workers' compensation (Nunes, 1998). This speaks to the impact on the plant's bottom line of the BBS education/training, subsequent observation and feedback strategies, and various employee-driven BBS interventions.

The most successful safety processes motivate "employees themselves to apply the techniques throughout their workplace" (Geller, 1996, p. 31), and thus effective procedures and support systems may vary dramatically across cultures. This study provides some support for providing employees choice during the design and administration of a BBS process. Our results also support the efficacy of the BBS approach to reducing workplace injuries, and demonstrate the potential benefits for incorporating involvement strategies in the customization of BBS processes for particular organizational cultures and work areas. It is hoped that our research will spark interest in understanding the mechanisms by which a successful technology may be made more effective and practical for long-term application.

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