Behavioral Safety Interventions

A review of process design factors

By. M. Dominic Cooper

BEHAVIORAL SAFETY has many advocates and many critics. Advocates have seen or experienced the effects of a well-designed process on incident rates (Cooper, 2003; Lyon, 2001; Veazie, 1999). Conversely, critics do not believe it truly involves workers in the overall safety process (Howe, 1998) and believe the concept has run its course (Naso, 2002). The promotion of operant theory (Skinner, 1953) within the behavioral safety field (Geller, 1996; McSween, 2002; Krause, 1997) has led many to believe that the antecedent-behavior-consequence model focuses almost exclusively on the psychology of safety.

In reality, like other safety management interventions, behavioral safety processes require a concerted effort by all to produce desired results. A simple five-step management model (known as CLEAR) shows there is no magic bullet involved:

- Clarify the objectives.
- Locate the problems.
- Execute the change strategy.
- Assess current progress.
- Review and adapt the process.

The purpose of a behavioral safety process is to reduce incidents triggered by unsafe or at-risk behaviors. To achieve this, specific behavioral problems are identified by focusing on incidents that result from the interaction between people and their working environment. This could include the presence, quality and functioning of various management systems (safety and nonsafety), the quality of leadership, resources available (financial and nonfinancial) and the overall safety culture (Cooper, 2000).

Once these problems are identified, attempts are made to discover which antecedents (e.g., unavailable equipment) are driving at-risk behavior (e.g., using improvised tools), and which consequences (e.g., saves time) are reinforcing or maintaining that behavior so that appropriate corrective actions can be taken. Executing the change strategy usually involves addressing the antecedents to remove barriers while the associated safety behaviors are placed on checklists so workers can conduct observations of ongoing behavior. Observation results are used to facilitate corrective feedback (i.e., a consequence) to those observed and to track overall progress. The trends in observation data over a period of time are used to adapt the process to suit the particular circumstances (e.g., change the behaviors on the observation checklists, provide tailgate topics).

M. Dominic Cooper, Ph.D., C.Psychol., CFIOSH, *is CEO of B-Safe Management Solutions Inc. in Franklin, IN. He has nearly 20 years' experience in the SH&E field. Cooper holds a B.S. in Psychology from University of East London, an M.S. in Industrial Psychology from the University of Hull and a Ph.D. in Occupational Psychology from the University of Manchester in the U.K. He is also a chartered psychologist with the British Psychological Society and a chartered fellow of the U.K.'s Institution of Occupational Safety & Health. Cooper emigrated to the U.S. in 2001 to join the faculty at Indiana University, Bloomington, where he taught safety education and industrial/organizational psychology. He is a member of ASSE's Central Indiana Chapter.*

Evolutionary Changes

Since its inception and application in the mid-1970s, behavioral safety has undergone a series of evolutionary changes. The first approach, popular in the early 1970s to mid-1980s, was largely a supervisory, top-down-driven process. Based on operant theory (Skinner, 1953), supervisors observed worker behavior, gave feedback and provided some form of positive or negative reinforcement. Behavior change did not last once reinforcers were removed. Simple and cheap to implement, this approach attracted legitimate criticism (Howe, 1998) that has since been hard to dispel.

Perhaps as a reaction to those criticisms, employee-led processes emerged during the early-1980s. In these interventions, which are still common, employees develop the overall process, conduct peer-to-peer or workgroup-based observations and provide feedback. However, the downside was (and is) the exclusion of management, leading to the common perception that behavioral safety processes focus solely on employee behavior (Hopkins, 2006).

This led, in the 1990s, to the cultural approach based on the concept of a managerial and employee partnership. Employees monitor the behavior of all members of a workgroup or work area, and managers regularly monitor their own safety-related leadership behaviors (e.g., whether they reviewed and closed out corrective actions). Everyone involved receives regular feedback, with some also receiving tangible reinforcers or incentives (Chandler & Huntebrinker, 2003). Surveys of behavioral safety users show that all three approaches are widely used around the world (Cooper, 2008).

Key Components of Behavioral Safety

Regardless of the approach adopted (all are based on the same psychological principles), many key structural components can affect the success of a behavioral safety implementation. Many primary academic research articles have addressed these (DePasquale & Geller, 1999; Sulzer-Azaroff & Austin, 2000) while others are based on received wisdom (Hurst & Payla, 2003). Each has tried to address the most efficient way to design the process to produce positive results in a cost-effective manner.

The components of an ideal process are:

- Identify unsafe behaviors (obtained from injury and near-hit incident records).
- Develop appropriate observation checklists (which feature behaviors implicated in injuries).
- Educate everyone. Tell and sell to all, and train observers, facilitators and champions.
- Assess ongoing safety behavior by conducting behavioral observations.
- Provide limitless feedback—verbal, graphical and written—on results.

Some processes go further and include goal-setting, training and/or incentives. Sulzer-Azaroff and Austin (2000) stated that the effectiveness of the various approaches is often dictated by the purpose of implementation. They cite variations in observation frequency and mechanisms of feedback, priorities, support structures and roles of key personnel. Variations in work settings (e.g., static and dynamic) and observation focus (e.g., individuals, workgroups, outcomes) are also factors.

Therefore, many process designs exist, some of which may be more effective in particular circumstances than others. For example, a behavioral process might be configured differently for static (e.g., manufacturing plant) or dynamic (e.g., construction) work settings that experience constant change in people or the working environment.

Observation Processes

Observations are the foundation of a behavioral safety process; they provide opportunities for verbal feedback and coaching at the point of contact. In principle, observations are analyzed to provide objective decision-making data (e.g., provide tailgate topics, identify training needs). Two aspects of observation processes might affect outcomes: frequency and focus.

In terms of observation frequency, most processes monitor the contact rate—the rate of contacts between observers and those observed. While some processes advocate daily contact (Cooper, 1998) because it provides a more reliable picture of ongoing safety performance, others recommend two or three times a week (Komaki, Barwick & Scott, 1978), once per week or a few times a year. Anecdotal evidence (Geller, 1996; McSween, 2002) suggests the greater the contact rate, the larger the impact on incident rates.

To date, the impact of observation focus on injury reduction and behavior change has not been assessed. Many processes adopt a one-on-one, peer-to-peer observation approach, where a trained observer approaches a colleague, asks permission to observe the person while working, then provides on-the-spot feedback once the observation is complete (Geller, 1996; Krause, 1997; McSween, 2002). This approach requires as many observers as possible and people willing to be observed. It also requires much time and effort to recruit observers and to sustain their motivation over the longer term (Whitney, 2006).

Other processes adopt a workgroup observation approach, where one or more trained observers embedded within each workgroup monitor the behavior of their colleagues during a single observation (Cooper, 1998). Typically, permission to observe is not required. Feedback is provided immediately if the observer is comfortable doing so. In addition, analyses of the workgroup observations for the entire week are discussed at weekly workgroup meetings. To avoid observer fatigue, colleagues rotate into that role every few months. This way, everyone eventually becomes an observer. At the same time, updating the behavioral checklists ensures a focus on relevant safety behaviors.

Self-observation approaches are often used for lone workers (e.g., drivers) who provide self-feedback when completing the observation checklist (Olsen & Austin, 2001). Compiled data are often analyzed for all lone workers to provide information about training needs and other corrective actions.

A less-common approach is to focus on outcomes of behavior. This approach is akin to weekly management walk-arounds focused on unsafe conditions. Typically, these will have a particular theme, such as housekeeping, PPE use or hazard identification. Again, employees receive immediate verbal feedback during these observation tours.

Feedback Mechanisms

Academic behavioral safety reviews (Cameron & Duff, 2007; Grindle, Dickinson & Boettcher, 2000; McAfee & Winn, 1989; Sulzer-Azaroff, Harris & McCann, 1994) indicate the importance of feedback, the purpose of which is to allow people to adjust their performance. Many processes use various combinations of available feedback mechanisms (e.g., verbal, graphical, written, tokens). Verbal feedback between the observed and observer at the point of contact is probably the most heavily used approach (Coplen, Ranney & Zuschlag, 2007). Correspondingly, behavioral safety steering committee members spend much time and effort recording and evaluating the quality of these feedback interactions, while simultaneously trying to keep the observations anonymous (no names recorded).

Many also display charts in the workplace to visually report trends in behavioral performance. In effect, they highlight how close to 100% safe the recorded observations indicate people are working. In some instances, a target (assigned by a steering

Abstract: *Behavioral safety interventions vary greatly across the facilities that have used them. This review of published literature examines the potential impact of process designs and their components to determine which are most effective. Injury reduction and behavior change are used as key effectiveness indicators.*

committee or set jointly by the workforce) is indicated on the chart as a motivational element of the process (Cameron & Duff, 2007).

Some processes also use written feedback based on an analysis of the compiled observation data. In some processes, workgroups receive the data at dedicated weekly briefings. In others, steering committees report the summary data to management each month or give it to focus groups with the explicit intention of eliminating barriers to performance. Some processes also provide tokens or incentives as a form of feedback to reinforce good performance.

Process Design Structure

Some processes make use of goal-setting, safety training, competition, incentives or a combination of these along with the observation and feedback components (Cameron & Duff, 2007). Goal-setting is motivational as it focuses people's attention and commits people to a particular course of action (Cooper, 1993).

In essence, there are three types of goals: implicit, assigned or participative. Feedback-only interventions use implicit goals, where the underlying assumption is to improve performance to 100% safe. Assigned goals are usually determined and set by those in authority, such as managers and steering committees, with no input from the workforce. Participative goals are set jointly and are agreed upon by all involved with reaching the goal.

Average levels of behavioral performance measured during a baseline period at the beginning of a process are used as the starting point to help set targets. In some cases, targets are changed as soon as the original target has been reached; in others, the target is set for a specific period to allow certain safety behaviors to become habitual.

Although not seen as an integral part of behavioral safety, safety training is usually present in some form. The initial training focuses on the at-risk behaviors identified in incident analysis. Thereafter, the training focuses on specific issues (e.g., manual handling) highlighted by analysis of observation data.

The use of competition between workgroups or departments and incentives in particular can be controversial because it can be viewed as paying for good safety performance (Gibb & Foster, 1996). Arguments for (Sims, 1999) and against (Krause, 1998) these methods have been published. Regardless, many behavioral safety processes (and safety in

Table 1

Studies Reviewed

Study	No. of data sets	Length of study (weeks)	Industrial setting	Contact rate	Observation focus	No. of feedback mechanisms	Training	Goal-setting	Feedback
Cooper, et al. (1994)	1	20	Cellophane factory	Daily	Workgroups	4		x	x
Cooper (2006a)	2	93	Metal refinery	Daily	Workgroups	4		x	x
Cooper (2006b)	1	70	Paper mill	Daily	Workgroups	4		x	x
Cooper & Newbold (1994)	1	11	Light bulb manufacturer	Intermittent	Workgroups	4			x
Fellner & Sulzer-Azaroff (1984)	1	60	Paper mill	Weekly	One-on-one	1			x
Haynes, et al. (1982)	1	36	Transit operations	Daily	Outcomes	3			x
Hodson & Gordon (2000)	1	104	Automotive parts	Weekly	One-on-one	1			x
Komaki, et al. (1978)	1	25	Food manufacturer	Intermittent	Workgroups	2	x	x	x
Komaki, et al. (1980)	1	45	Vehicle maintenance	Intermittent	Workgroups	2	x		x
Larson, et al. (1980)	3	104	Police	Daily	Outcomes	1			x
Mattila & Hyödynmaa (1988)	2	20	Construction	Weekly	Workgroups	2		x	x
Nasanen & Saari (1987)	1	60	Shipbuilding yard	Intermittent	Outcomes	2			x
Reber & Wallin (1984)	1	56	Sugar cane machinery	Intermittent	One-on-one	1	x	x	x
Reber, et al. (1990)	3	55	Farm machinery	Intermittent	One-on-one	1	x	x	x
Reber & Wallin (1994)	1	88	Offshore diving	Intermittent	One-on-one	3	x	x	x
Winn, et al. (1999)	1	60	U.S. Postal Service	Intermittent	One-on-one	3			x
Zhu, et al. (2000)	2	52	Oil rigs	Daily	Workgroups	1	x	x	x

general) often use competition to reinforce and/or reward good performance.

Given the complexity and variety of approaches, it makes sense to try to identify the optimum design of a behavioral safety process. Academic studies have established that behavioral safety works. However, to date no review has examined the potential impact of process designs and their components to determine which are most effective. The author's study attempted to do so using injury reduction and behavior change as key effectiveness indicators.

Method

Literature Search

A wide-ranging literature search located 106 professional and academic behavioral safety articles. These were examined and included in this review only if they 1) focused solely on occupational safety; 2) quantified behavioral change and incident reductions; 3) stated observation contact rates; and 4) were written in English. Seventeen studies met these criteria. Of these, five reported the results of two or more separate studies within the article. In total, this provided 24 useable data sets (Table 1).

Common study characteristics were identified and coded. The fundamental components included 1) the focus of monitoring (individuals, workgroups, outcomes); 2) observation frequency; and 3) feedback mechanisms used (posted, verbal, written, briefings). Component structures included safety training, goal-setting and incentives or competition. Study outcomes were the degree of injury reduction and behavioral improvement.

Data Transformations

Many of the studies reported success in different ways. To ensure equitable comparisons, several data transformations were required:

- **Behavioral change.** The degree of behavioral improvement was obtained directly from the reported statistics or by subtracting the reported baseline score from the final intervention score when the specific degree of improvement was not reported.
- **Incident reduction.** A similar procedure ascertained the degree of injury reduction. In one study containing three data sets (Reber, Wallin & Chokar, 1990), baseline injury figures encompassed the preceding 3 years, rather than the corresponding period in the previous 12 months. This could inflate or deflate the claimed degree of injury reduction. To ensure correct comparison with the other studies, the reported injury rate baseline was divided by 36 months to obtain an average monthly injury rate. The product was multiplied by 12 to obtain an estimate of the prior annual injury rate.
- **Incident rates.** The calculation of reported injury rates also differed across the studies. Some were based on 100,000 or 200,000 hours worked and some on 1 million hours. All injury rates were recalculated to reflect the rate for 200,000 hours worked. This did not affect the magnitude of change within any individual study, it merely facilitated like-for-like comparisons across the studies.

Analytic Method

Meta-analysis is a quantitative review method commonly used to synthesize data from multiple studies (Hunter & Schmidt, 1990) to provide an estimate of the mean treatment effect. This requires the use of a common metric and is usually obtained by converting the results of each study into a standardized difference score (*d*) or correlation coefficient (*r*). Accumulated across all studies of interest and corrected for error, the outcome provides statistically valid estimates of the mean treatment effect.

Cohen's standardized difference score (*d*) is the statistic used in this review. In essence, this is obtained by dividing any gain in scores ($X_{pre} - X_{post}$) resulting from an intervention, by the spread of scores (SD_{pooled}). In other words, Cohen's *d* is the difference in mean scores divided by the pooled standard deviation of the relevant before and after scores. As such, *d* represents standard deviation units. When greater than 0.8 the effect is considered large (Cohen, 1992), but not necessarily statistically significant. Confidence intervals are used to determine statistical significance. When the range between the upper and lower limits exclude zero, the results are considered statistically significant. Conversely, confidence intervals that include zero (i.e., no effect) are not considered statistically significant.

Given the complexity of the process and variety of approaches used in workplaces to implement behavioral safety, it makes sense to try to identify the optimum design of a behavioral safety process.

Analysis of Study Characteristics

The injury and behavior change data for each study were transformed into common treatment effect sizes (Cohen's *d*) using dedicated meta-analytic software (Borenstein & Rothstein, 1999). For each component or process design, the studies were separated into groups containing the same characteristics and analyzed to establish the degree of behavior change and injury reduction.

For each analysis, the accumulated and averaged treatment effect sizes of the various behavioral safety components form the basis for the reported results. The meta-analytic software also produces confidence intervals and significance tests. Those failing to achieve significance are highlighted by *ns.* All other results achieved statistical significance at either 0.01 (99%) or 0.05 (95%) levels (Table 2, p. 40).

Results

Overall Results

The 17 studies were conducted in the U.S. ($n = 12$) and Europe ($n = 5$). The total number of people involved in all the studies was 25,852. The average length of the studies was 60 weeks (range = +/- 30). For all studies combined, Cohen's *d* was 3.18 for behavior change and 5.21 for injury rate reduction. These large effect sizes show that behavioral safety processes positively affect behavior and reduce incident rates.

Table 2

Degree of Behavior Change & Injury Reduction

Design elements	No. of studies in analysis	Avg. no. of employees	Incident rate effect size (Cohen's *d*)	*P* <	Behavior change effect size (Cohen's *d*)	*P* <
All studies	**24**	147	5.21	**0.01**	3.18	**0.01**
Work setting						
Static settings	13	207	6.6	0.01	4.2	0.01
Dynamic settings	11	76	3.6	0.01	1.9	0.01
Contact rate						
Daily	10	205	7.0	0.01	3.3	0.01
Intermittent	10	57	5.8	0.01	3.5	0.01
Weekly	4	237	0.70	*ns*	1.9	*ns*
Observation focus						
Workgroup	11	178	7.1	0.01	3.9	0.01
Outcomes	8	156	5.5	0.01	2.2	0.01
Individuals (one-on-one)	5	71	2.5	0.01	2.8	0.01
Observation focus by work setting						
Workgroups - static settings	7	244	10.87	0.01	5.4	0.01
Outcomes - dynamic settings	5	71	5.47	0.01	2.18	0.01
Individuals - dynamic settings	2	113	5.02	0.05	2.42	0.01
Individuals - static settings	6	163	1.65	0.05	2.88	0.01
Workgroups - dynamic settings	4	63	0.47	*ns*	1.36	0.01
Feedback mechanisms						
Posted, verbal, written and weekly brief	5	324	10.5	0.01	6.7	0.01
Posted and verbal	1	32	8.9	0.01	3.4	0.01
Posted, verbal and written	1	165	7.3	0.01	1.7	0.01
Verbal only	4	138	4.8	0.01	1.9	*ns*
Posted only	12	91	2.9	*ns*	2.2	0.01
Verbal, written and weekly brief	1	61	2.7	0.01	3.2	0.01
No. of feedback mechanisms						
3-4 mechanisms	8	243	8.9	0.01	5.51	0.01
1-2 mechanisms	16	99	3.7	0.01	2.21	0.01
Process design structure						
Training and feedback	1	55	12.2	0.01	1.3	0.01
Goals and feedback	6	285	8.7	0.01	4.1	0.01
Training, goals and feedback	8	66	5.8	0.01	2.4	0.01
Feedback only	8	104	3.5	0.01	3.3	0.01
Competition, incentives and feedback	1	100	2.8	0.01	4.5	0.01
Goal type						
Participative	4	398	9.92	0.01	5.62	0.01
Implicit	10	111	6.16	0.01	3.21	0.01
Assigned	10	65	2.34	*ns*	2.16	0.01

Work Settings

The studies included 13 static (e.g., automotive, manufacturing, metal refining, postal services, vehicle maintenance) and 11 dynamic (e.g., construction, offshore oil and gas, police services, shipbuilding and transit operations) work settings. As shown in Figure 1, processes implemented in static settings reduced the average incident rate by 6.6 *SD* units, compared to 3.6 *SD* units in dynamic settings. Behavior changes were also twice as large in static (d = 4.2) settings compared to dynamic settings (d = 1.9). Thus, in these reviewed studies, behavioral safety appears to work better in static settings, with stable workforces and/or in stable environments.

Observation Frequency

Contact rate was grouped into three observation conditions: daily, intermittent (2 or 3 days per week) and weekly. Six studies reported daily observations, with data for 10 interventions (Table 2). Eight studies observed two or three times per week, with 10 data sets. Three studies observed weekly with four sets of data.

The results (Figure 2) reveal that daily contact led to greater injury reduction (d = 7.0) than intermittent contact (d = 5.8), but the latter exerted a slightly larger impact on behavioral change. For weekly observations, the impact on injury reduction and behavior change was not statistically significant (d = 0.7), signaling minimal contact rates will not always change behavior or reduce injuries.

Observation Focus

Eight studies encompassing 11 data sets contained workgroup observations. Six studies with eight data sets used individual one-on-one observations, while three studies with five data sets observed the outcomes of behavior (e.g., housekeeping).

Figure 3 (p. 42) shows that injury reduction was greater for workgroup based observations (d = 7.1) than a focus on outcomes (d = 5.5) or individuals (d = 2.5). Similarly, greater behavioral change was reported for workgroups (d = 3.9) followed by individual one-on-one observations (d = 2.8) and outcome-based approaches (d = 2.2). As outcome-based approaches explicitly focus on unsafe conditions where behavior change is indirect, greater behavior change for workgroup and individual approaches is not surprising. As a whole, these results show that workgroup observations are more effective than one-on-one, peer-to-peer observations.

Because many case studies suggest that one-on-one observations are effective, the studies were further analyzed by observation focus and work setting to assess possible situational impacts. Incident rate reductions (Figure 4, p. 42) show a clear effect of situational influences on observational approaches.

Workgroup observations were far more effective in static (d = 10.87) than dynamic (d = 0.47, *ns*) settings. Explanations may reside in ideal culture change conditions arising from long-term stable workgroups in static settings, compared to transient workforces in dynamic settings.

One-on-one approaches reduce injuries significantly more in dynamic (d = 5.02) than static (d = 1.65) settings. Little differences were found for behavior change, suggesting that one-on-one observation approaches lend themselves to dynamic settings. Both one-on-one and outcome-based observations (d = 5.47) were better than workgroup (d = 0.47) observations in dynamic settings.

Feedback Mechanisms

All studies included verbal feedback, with 14 (providing 19 data sets) using posted feedback charts, six studies (with seven data sets) providing a written analysis of observation results and five studies (with six data sets) using weekly briefings with employees. Separated into feedback method groups, three groupings contained only one study, the results of which are viewed solely as indicative, not definitive.

Figure 5 (p. 43) shows the impact the various feedback mechanisms exerted on incident reduction and behavior change. Of the groups containing more than one study, a combination of posted, verbal and written feedback presented at weekly briefings was the most effective method. Effect sizes for injury reduction (d = 10.5) and behavior change (d = 6.7) was much greater than other combinations. Perhaps this reflects the increased opportunities for discussion between all involved to address

Figure 1

Changes in Behavior & Injury Reduction by Work Setting

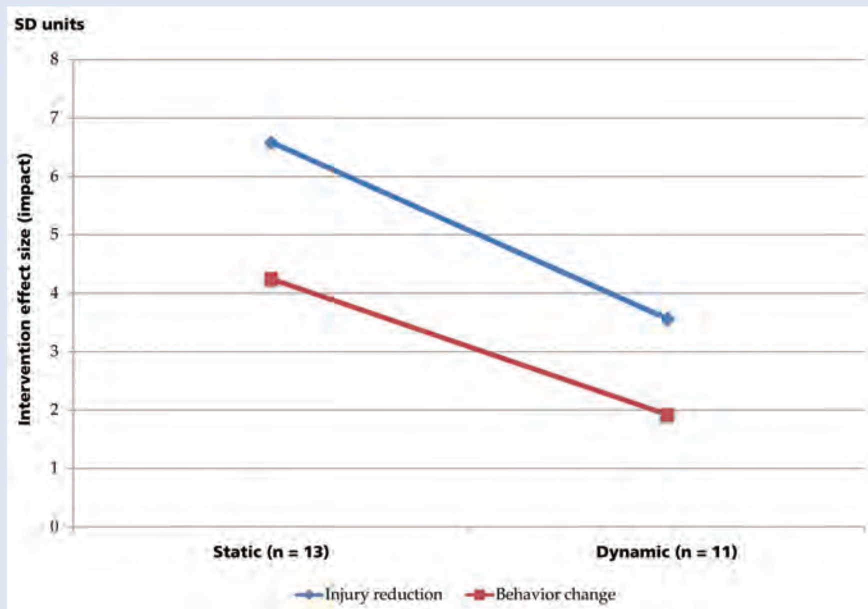


Figure 2

Changes in Behavior & Injury Reduction by Contact Rate

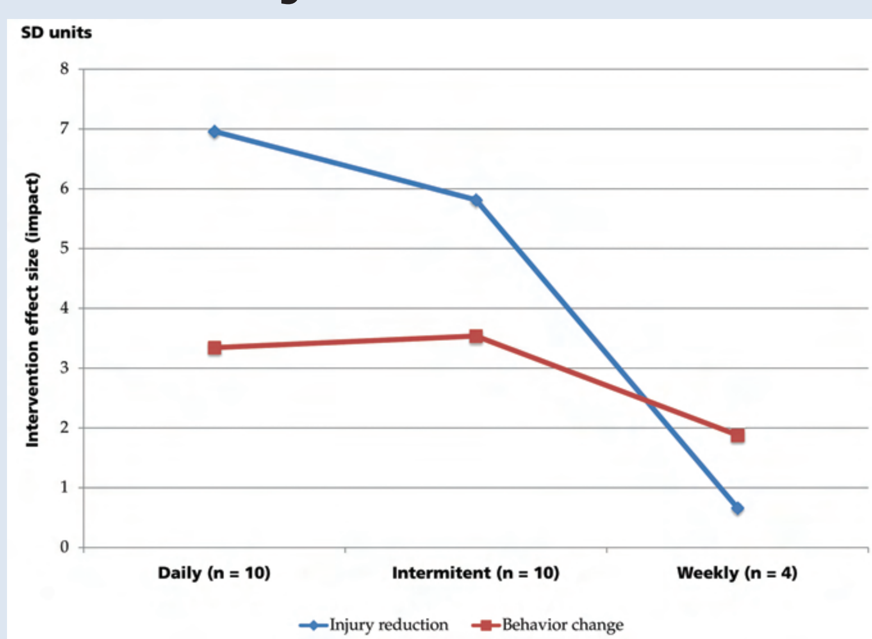


Figure 3

Changes in Behavior & Injury Reduction by Observation Focus

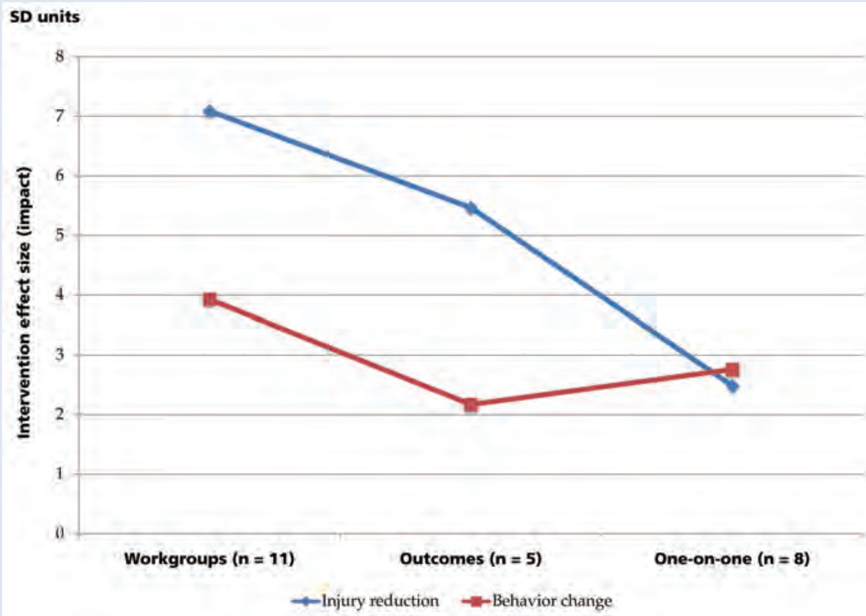
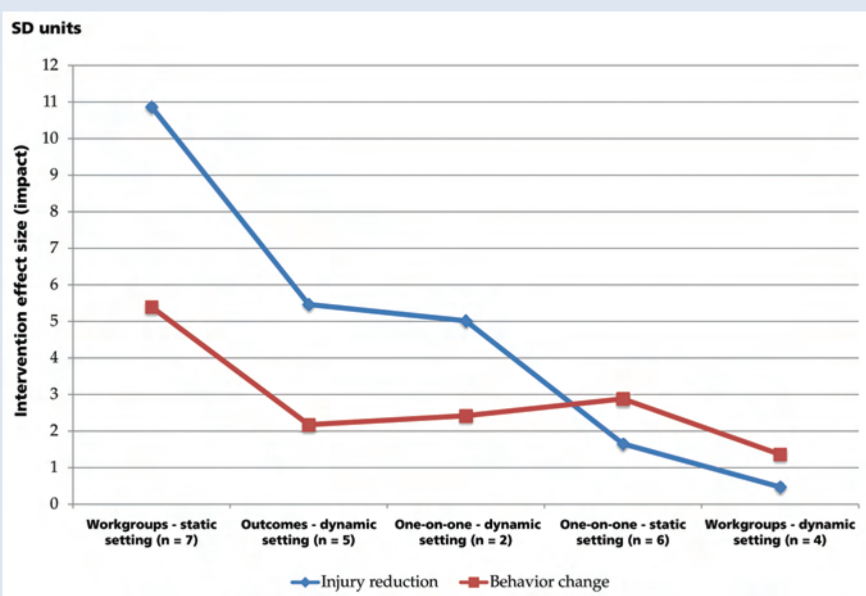


Figure 4

Changes in Behavior & Injury Reduction by Observation Focus & Work Setting



reasons for particular unsafe behaviors. Verbal feedback was effective for injury reduction (d = 4.8) but did not lead to statistically significant behavior changes (d = 1.9). Conversely, posted feedback produced behavioral changes (d = 2.2) but nonsignificant injury reductions (d = 2.9).

Due to the limited number of studies in three feedback groupings, studies were subdivided into those using one to two or three to four mechanisms. Analyses revealed that more feedback mechanisms led to greater injury reduction (d = 8.9 vs. 3.7) and larger behavioral improvement (d = 5.51 vs. 2.21). These results (Figure 6) hold for injury reduction in both static and dynamic settings. This is also mostly true for behavior change, except one to two feedback mechanisms (d = 2.66) was slightly better than three to four mechanisms (d = 2.4) in dynamic settings.

Design Structure

In terms of goal-setting, eight of the studies made use of implicit goals, with 10 data sets. Six studies used assigned goals providing 10 data sets, while three studies used participative goals, providing four data sets. Six studies included training in their interventions, providing nine data sets, with only one making use of competition and incentives.

The analysis of the various design structures produced interesting results (Figure 7, p. 44). First, the effects of design structure are on injury reduction rather than behavior change. Ignoring the two designs with only a single study, goal-setting and feedback (d = 8.7) reduced injuries more than training, goal-setting and feedback (d = 5.8) and feedback only (d = 3.5) designs.

At first glance, this suggests that the motivational effects of explicit safety improvement goals are neutralized by safety training. However, six of the eight studies in the training, goal-setting and feedback condition used assigned goals, which proved to be the least effective for injury reduction (Figure 8, p. 44). Both participative (d = 9.92) and implicit (d = 6.6) goals were more effective at reducing injuries than assigned goals (d = 2.3), which produced nonsignificant reductions. Behavioral change was also greater when participative goals were used (d = 5.6) compared to implicit (d = 3.2) and assigned goals (d = 2.16).

Discussion

This behavioral safety review revealed some interesting findings, some of which support popular opinion, others which contradict it. Based on the studies reviewed, behavioral safety does improve safety behavior and reduce injuries. However, the studies also show that some process designs are more effective than others.

Injury reductions and behavior changes in static settings were twice those of dynamic settings. Within static settings, a workgroup approach reduced injuries about six times more than a one-on-one observation focus on individuals. Since about

51% of behavioral safety processes observe individuals (Cooper, 2008), this is an important finding. Workgroup observations are probably more effective because of peer pressure resulting from social dynamics within a workgroup (Mullen & Copper, 1994). This helps people perform safely even when not being observed. Similarly, group feedback is more effective than one-on-one feedback to individuals (Alvero, Bucklin & Austin, 2001). Together, these factors help to positively reset group norms, which in turn positively influences the prevailing safety culture (Cooper, 2000).

That behavioral safety works in dynamic settings is good news, as implementations can be very difficult in settings where people, the working environment or both, change regularly. In these environments, observing outcomes (e.g., unsafe conditions) reduced injuries slightly more than monitoring individuals, both of which significantly reduced injuries more than workgroup-focused approaches. This shows workgroup observations are more effective in static settings, while one-on-one observations are more suited to dynamic settings. Thus, a focus on unsafe conditions in conjunction with one-on-one observations have an important role to play in settings where the people and/or the environment are subject to continual change.

Supporting the anecdotal evidence in the field, daily or intermittent contact rates produced larger effects on both behavior and injury reduction than weekly contact rates, which produced nonsignificant changes. Approximately 47% of behavioral safety processes use a weekly contact rate (Cooper, 2008), which suggests that increased contact rates would benefit these users. Greater contact rates for line management's weekly inspections would also help to maintain a consistent focus on safety, which, in turn, may lead to further injury reductions.

Processes that use three to four feedback mechanisms had more than twice the impact on injuries and behavior than those with one to two mechanisms, in both static and dynamic settings. The overall message, therefore, is to "use it is to make it useful." Behavioral safety processes should use as many feedback mechanisms as possible to facilitate any necessary adjustments in performance (Algera, 1990). Different people pay attention to different forms of feedback and by using several mechanisms people may perceive they are part of the safety improvement process, not the problem. More feedback also transmits the message that safety is important and taken seriously by the company.

Although feedback alone reduces injuries and changes behavior, processes incorporating explicit

Figure 5

Changes in Behavior & Injury Reduction by Feedback Mechanism

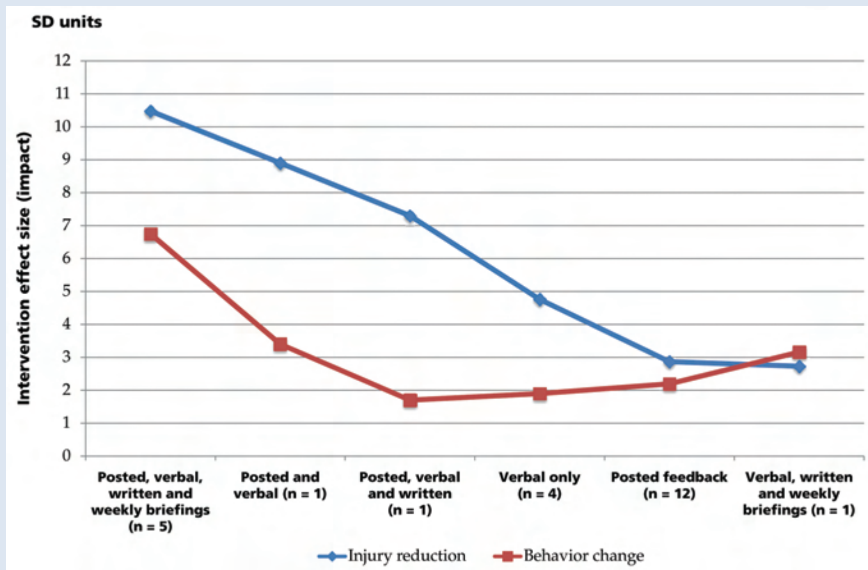
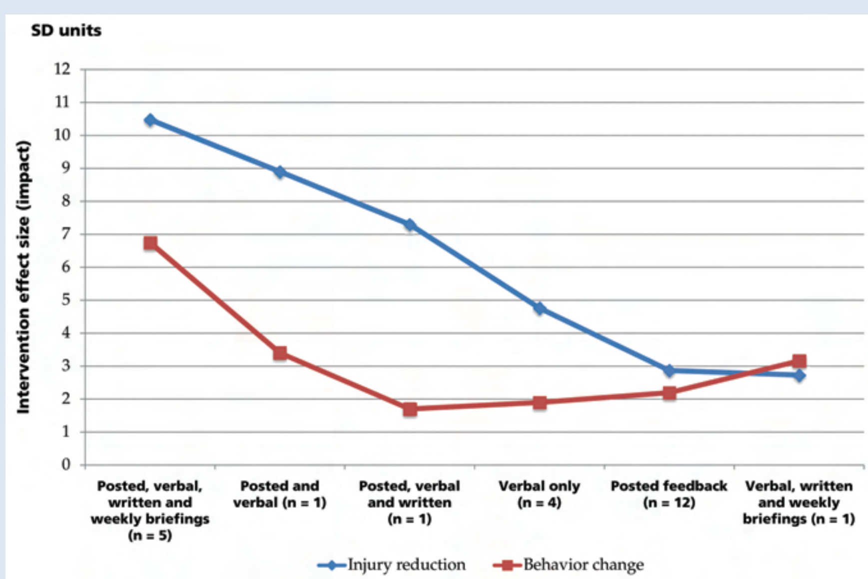


Figure 6

Changes in Behavior & Injury Reduction by Number of Feedback Mechanisms



goals and/or training about the behavioral targets were between one and two times more effective, suggesting these designs helped to maximize the benefits of the process. However, participative goals were superior to assigned goals, which produced nonsignificant injury reductions. The likely reason participative goals are more effective is that employees jointly work out the best ways to achieve their goals (Locke & Latham, 2002), which induces commitment to goal achievement (Cooper, 1992; Ludwig & Geller, 1997).

Figure 7

Changes in Behavior & Injury Reduction by Design Structure

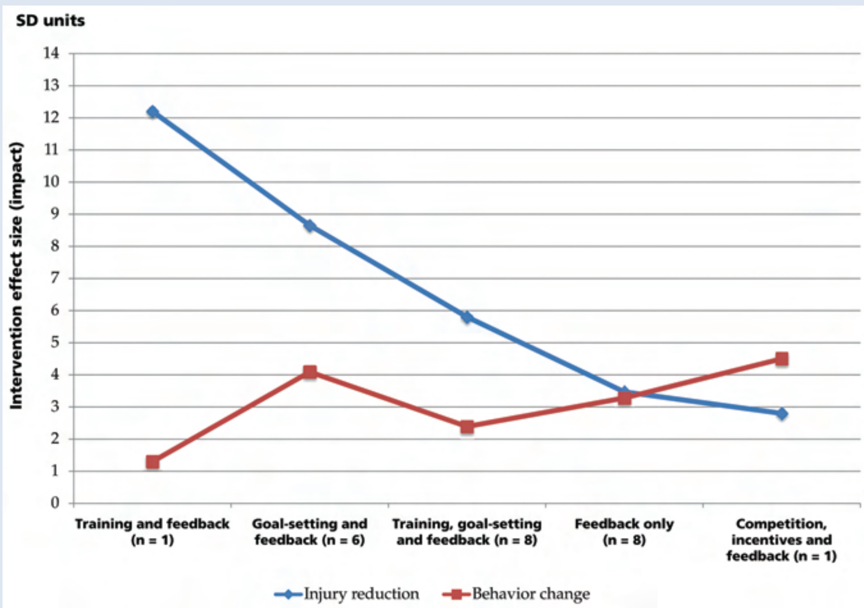
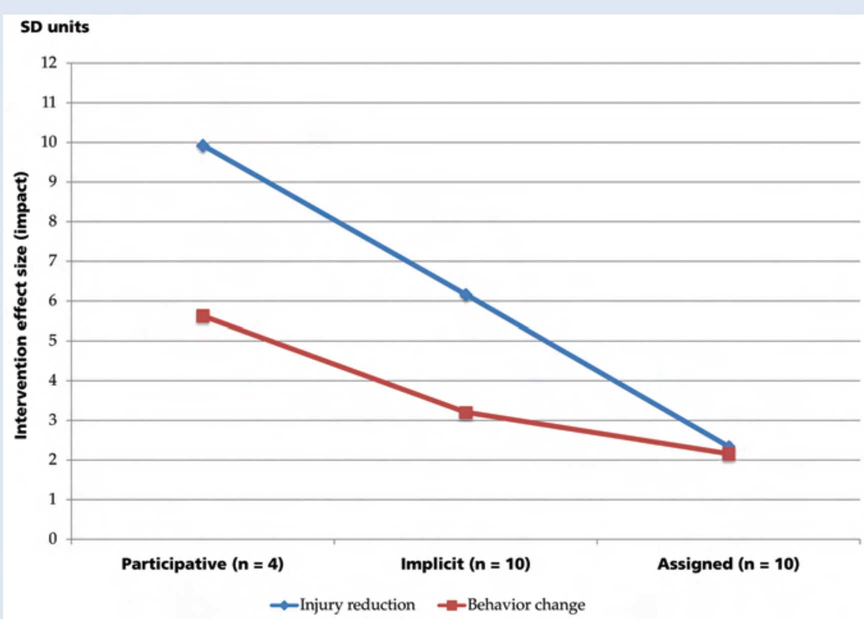


Figure 8

Changes in Behavior & Injury Reduction by Goal Type



Limitations

One limitation of this review was the relatively small number of published research studies that fit the established criteria for inclusion. Excluding some published articles simply because they did not report the appropriate change statistics or failed to specify the observation contact rate meant some groupings of design characteristics were limited to only one or two studies.

For example, only one study was available in the training and feedback group, so it was not possible to draw meaningful conclusions about the effectiveness of this design. This also restricted the analyses of other possible design combinations. Many companies and providers have implemented behavioral safety using various designs. These could and should be analyzed and published as case studies so that behavioral safety can evolve to the point where it always works, in all types of work settings.

Conclusion

The results of this review show that the design of a behavioral safety process is as important as the psychology of behavioral safety (all studies reviewed are based on the same psychological research). Simply measuring behavior and providing consequences is not enough to sustain incident reduction. Designs that incorporate daily observations, focus on workgroups in static settings and use participative goals with multiple feedback mechanisms will reduce injuries more than others. All behavioral safety processes require strong management support to help deliver the intended benefits and sustain them over the longer term (Cameron & Duff, 2007; Cooper, 2006a; 2006b). Without it, even the best designed process can fail. ■

References

Algera, J.A. (1990). Feedback systems in organizations. In C.L. Cooper and I.T. Robertson (Eds.), *International review of industrial and organizational psychology* (pp. 169-193). New York: John Wiley & Sons.

Alvero, A.M., Bucklin, B.R. & Austin, J. (2001). An objective review of the effectiveness and essential characteristics of performance feedback in organizational settings (1985-1998). *Journal of Organizational Behavior Management, 21,* 3-29.

Borenstein, M. & Rothstein, H. (1999). *Comprehensive meta-analysis: A computer program for research synthesis.* Englewood, NJ: BioStat.

Cameron, I. & Duff, A.R. (2007). A critical review of safety initiatives using goal-setting and feedback. *Construction Management and Economics, 25,* 495-508.

Chandler, B. & Huntebrinker, T.A. (2003, June). Multisite success with systematic BBS: A case study. *Professional Safety, 48*(6), 35-42.

Cohen, J. (1992). Statistical power analysis. *Current Directions in Psychological Science, 1,* 98.

Cooper, M.D. (1992). An examination of assigned and participative goal-setting in relation to the improvement of safety on construction sites. Unpublished doctoral dissertation, University of Manchester Institute of Science & Technology, U.K.

Cooper, M.D. (1993, Nov.). Goal-setting for safety. *Safety & Health Practitioner,* 32-38.

Cooper, M.D. (1998). *Improving safety culture: A practical guide.* Chichester, U.K.: John Wiley & Sons.

Cooper, M.D. (2000). Towards a model of safety culture. *Safety Science, 32,* 111-136.

Cooper, M.D. (2002, June). Safety culture: A model for understanding and quantifying a difficult concept. *Professional Safety, 47*(6), 30-36.

Cooper, M.D. (2003, April). Behavior-based safety still a viable strategy. *Safety+Health,* 46-48.

Cooper, M.D. (2006a). Exploratory analyses of the effects of managerial support and feedback consequences on behavioral safety maintenance. *Journal of Organizational Behavior Management, 26,* 1-41.

Cooper, M.D. (2006b). The impact of management's commitment on employee behavior: A field study. *Proceedings of the 7th Professional Development Conference & Exhibition, Kingdom of Bahrain,* 40-47.

Cooper, M.D. (2008). User survey report. Franklin, IN: Behavioral-Safety.com. Retrieved March 13, 2008, from http://www.behavioral-safety.com/survey-results/finalsurveybscom1.html.

Cooper, M.D., Phillips, R.A., Sutherland, V.J., et al. (1994). Reducing accidents with goal-setting and feedback: A field study. *Journal of Occupational and Organizational Psychology, 67,* 219-240.

Cooper, S.E. & Newbold, R.C. (1994). Combining external and internal behavioral system consultation to enhance plant safety. *Consulting Psychology Journal, 46,* 32-41.

Coplen, M., Ranney, J. & Zuschlag, M. (2007, Feb.). Behavior-based safety at Amtrak-Chicago associated with reduced injuries and costs. *U.S. Department of Transportation Research Results,* 1-4.

DePasquale, J.P. & Geller, E.S. (1999). Critical success factors for behavior-based safety: A study of 20 industry-wide applications. *Journal of Safety Research, 30,* 237-249.

Fellner, D.J. & Sulzer-Azaroff, B. (1984). Increasing industrial safety practices and conditions through posted feedback. *Journal of Safety Research, 15,* 17-21.

Geller, E.S. (1996). *The psychology of safety: How to improve behaviors and attitudes on the job.* Boca Raton, FL: CRC Press.

Gibb, A.G.F. & Foster, M. (1996). Safety motivation: evaluation of incentive schemes. In L.M. Alves Dias and R.J. Coble (Eds.) *Implementation of safety and health on construction sites* (pp. 405-415). Rotterdam, Netherlands: Balkema.

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

Haynes, R.S., Pine, R.C. & Fitch, H.G. (1982). Reducing accident rates with organizational behavior modification. *Academy of Management Journal, 25,* 407-416.

Hodson, S. & Gordon, T. (2000, May). Tenneco's drive to become injury-free. *Occupational Hazards, 5,* 85.

Hopkins, A. (2006). What are we to make of safety behavior programs? *Safety Science, 44,* 583-597.

Howe, J. (1998). A union critique of behavior safety. Paper presented at the ASSE Behavioral Safety Symposium, Orlando, FL.

Hunter, J.E. & Schmidt, F.L. (1990). *Methods of meta-analysis: Correcting error and bias in research findings.* London: Sage.

Hurst, P.W. & Payla, W.L. (2003, Sept.). Selecting an effective BBS process. *Professional Safety, 48*(9), 39-41.

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

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

Krause, T.R. (1997). *The behavior-based safety process* (2nd ed.). New York: Van Nostrand Reinhold.

Krause, T.R. (1998, May). Safety incentives from a behavioral perspective. *Professional Safety, 43*(5), 24-28.

Krause, T.R. (2001, May). Moving to the second generation in behavior-based safety. *Professional Safety, 46*(5), 20-25.

Larson, L.D., Schnelle, J.F., Kirchner, R., et al. (1980). Reduction of police vehicle accidents through mechanically aided supervision. *Journal of Applied Behavior Analysis, 13,* 571-581.

Locke, E.A. & Latham, G.P. (2002). Building a practically useful theory of goal-setting and task motivation: A 35-year odyssey. *American Psychologist, 57*(9), 705-717.

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

Lyon, B.K. (2001, Oct.). Behavioral sampling of theme park operators. *Professional Safety, 46*(10), 35-42.

McAfee, R.B. & Winn, A.R. (1989). The use of incentives/feedback to enhance workplace safety: A critique of the literature. *Journal of Safety Research, 20,* 7-19.

McSween, T.E. (2002). *The values-based safety process: Improving your safety culture with a behavioral approach* (2nd ed.). New York: John Wiley & Sons.

Mattila, M. & Hyödynmaa, M. (1988). Promoting job safety in building: An experiment on the behavior analysis approach. *Journal of Occupational Injury, 9,* 255-267.

Mullen, B. & Copper, C. (1994). The relation between group cohesiveness and performance: An integration. *Psychological Bulletin, 115,* 2210-2227.

Naso, M. (2002, Dec.). Change in behavior: The decline of behavior-based safety gives way to safety management initatives. *Safety+Health,* 33-39.

Näsänen, M. & Saari, J. (1987). Effects of positive feedback on housekeeping and accidents at a shipyard. *Journal of Occupational Accidents, 8,* 237-250.

Olsen, R. & Austin, J. (2001, Nov.). ABCs for lone workers: A behavior-based study of bus drivers. *Professional Safety, 46*(11), 20-25.

Reber, R.A. & Wallin, J.A. (1984). Reducing industrial injuries: A behavioral experiment. *Employee Relations, 23,* 119-124.

Reber, R.A. & Wallin, J.A. (1994). Utilizing performance management to improve offshore oilfield diving safety. *International Journal of Organizational Analysis, 1,* 88-98.

Reber, R.A., Wallin, J.A. & Chokar, J. (1990). Improving safety performance with goal-setting and feedback. *Human Performance, 3,* 51-61.

Saari, J. (1994). When does behavior modification prevent injuries? *Leadership and Organization Development Journal, 15,* 11-15.

Sims, W. Jr. (1999, April). Successful safety incentive programs. *Professional Safety, 44*(4), 37-39.

Skinner, B.F. (1953). *Science and human behavior.* New York: Free Press.

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

Sulzer-Azaroff, B., Harris, T.C. & McCann, K. (1994). Beyond training: Organizational performance management techniques. *Occupational Medicine: State of the Art Reviews, 9,* 321-339.

Veazie, R. (1999, April). Foundation principles: Keys to success of a behavior-based safety initiative. *Professional Safety, 44*(4), 24-26.

Whitney, P. (2006). How behavior-based safety can work in different national cultures. Paper presented at the Behavioral Safety Now Conference, Kansas City, MO.

Winn, G.L., Fredrick, L.J. & Church, G.M. (1999, Dec.). Unions and behavior-based safety: Always the odd couple? *Professional Safety, 44*(12), 32-34.

Zhu, Z., Wallin, J.A. & Reber, R.A. (2000). Safety improvements: An application of behavior modification techniques. *Journal of Applied Management Studies, 9,* 135-140.