2.1.3. Feedback Programs

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2.1.3. Feedback Programs

Mining companies take many initiatives to reduce the number of preventable safety incidents. One approach—noteworthy for its evidenced effectiveness, versatility, and ease of application—is behaiviour and/or performance feedback. *Feedback* involves the provision of data describing personal or group performance (Ludwig, Geller, & Clark, 2010). Feedback may occur in different domains (e.g., job performance, safety, personal health, etc.) and may be given to a variety of populations (e.g., supervisors, workers, upper management, etc.) to enhance workplace performance including safety on several levels (e.g., behaviours, accident rates, and safety climate, etc.). In this review we analyze the literature that investigates a usage of feedback in occupational settings and identifies several factors of their successful application.

The question that guided our scoping review was: "Is feedback an effective tool for enhancing workplace safety?"

Method

Search strategy. Unlike most topics, articles selected for this chapter were not retrieved using a standard database search and formal search strategy. This is because it was originally thought that all existing safety interventions would be included under one topic. However, given, the multitude of existing literature, feedback-based interventions were compiled into their own chapter. Consequently, articles on feedback were extracted from the pool of literature obtained through all other search strategies conducted by the U of S team (i.e., already included and screened within other U of S topics).

The majority of articles included in this chapter were retrieved through the search strategies created for the original "Behaviour Changing Strategies" and "Existing Safety Interventions" topics that were since re-structured for the final report. The search strategies developed for these original topics were:

- Program (safety program, applied psychology, engineering psychology, environmental psychology, "industrial and organizational psychology", social psychology, strategies, safety approach, intervention, group intervention, safety procedures, safety protocols, program evaluation, program development, evaluation, evaluation criteria, safety intervention, accident prevention)
- Specific types of programs (tool box talks, safety observations, safety meetings, workplace incentives, incident investigations, standard operating procedure, safety talks, safety manual, safety messages, management by walking around, goal setting, problem solving, feedback)
- Incentives and punishment (incentives, awards, merit, goals, reinforcement, professional recognition, bonuses, token economy programs, criticism)
- Clinical strategies (psychotherapy, cognitive behavioural therapy, behaviour modification, classroom behaviour modification, contingency management, fading, omission training, overcorrection, self-management, time out, behaviour therapy, cognitive restructuring, change strategies, behaviour change, social support, behaviour/behavior based safety)
- Other strategies (conditioning, behaviour analysis, evidence based practice, behavioural

economics, mindfulness, hypnosis)

- Safety engagement (see General Method section).

The searches were undertaken between September 2014 and April 2015.

Screening strategy. Articles ultimately included in this chapter. were first screened within the topic they were originally included under; thus, articles were already excluded based on publication date (e.g., published before 2010), irrelevant records (e.g. non English), irrelevant mediums (e.g., book reviews, letters to editor, etc.), and irrelevant safety domains (e.g., sexual risk taking, gambling, etc.) were already removed. Articles were only added to this chapter if they were specifically relevant to feedback-based interventions; thus, no further screening was needed and inclusion/exclusion criteria were not developed.

Results

Description of included articles. A brief summary of each article including its location, population studied, main issue addressed, comparison group, and primary outcomes is provided in Appendix G. The following is an overview of the included articles.

Table 1. Number of Articles by databases searched for original Behaviour Changing Strategies and Existing Safety Programs topics combined; articles selected for review were divided into all current safety program topics.

Database	Articles found from original searches combined	Articles Selected For Review	Final article Selection
ABI	3061	7443	12
Academic Search Complete	4762		
CBCA Complete	1407		
CINAHL	3162		
EMBASE	4694		
MEDLINE	2932		
ProQuest Dissertations & Theses	5522		
PsycINFO	12033		
Scopus	3347		
SocINDEX	2316		
Sociological Abstracts	422		
Web of Science	2935		

Table 2. Feedback Number of Articles by Type, Country, and Population

Type of Publication:	Country of Publication:	Population Studied:
- 10 original research articles - 1 summary discussion - 1 systematic review **Type of Original Research:** - 3 program evaluations - 3 surveys - 2 experimental designs - 2 qualitative studies	- 4 USA - 2 Germany - 1 UK - 1 Australia - 1 Israel - 1 South Korea - 1 Malaysia - 1 Japan	- 3 Motorists - 2 Manufacturing - 2 Construction - 1 Coal Mining - 1 Transportation - 1 Military - 1 Healthcare - 1 Industry (unspecified) - 1 general (i.e., did not distinguish between job type or industry)

Although little research has been conducted on mining employees specifically, knowledge obtained in other industries/workplaces may be generalized to this population.

Description of identified factors. Based on a descriptive analysis of the selected articles conducted in Stage 1, four factors were identified: (1) effectiveness of providing feedback, (2) visual feedback, (3) Specificity of feedback and feedback generalization, and (4) potential issues of feedback interventions. The primary results and potential applications of each identified factor are discussed. All definitions of concepts as used in the current literature are provided in Appendix D.

Effectiveness of providing feedback. Eight articles were related to effectiveness of feedback applications. Though feedback can be given concerning many variables (e.g., performance, safety, personal health, etc.) to employees of any status (e.g., supervisors, upper management, etc.), the effectiveness of feedback is most evident in safety feedback interventions given to front-line workers. The effectiveness of feedback can be further enhanced by including goal-setting practices and targeting both individuals and groups.

Safety feedback. The most prevalent form of feedback in our analysis, safety feedback (i.e., providing feedback regarding safety-related actions), has displayed considerable effectiveness in reducing incident rates (Cheah, Giloi, Chang, & Lim, 2012), increasing safety rule compliance (Cheah et al., 2012; Spiegel, Spiegel, Brandt, & Strupp, 2010), and increasing safe behaviours (Baker, 1998; Cameron, 2007; Cheah et al., 2012; Lee et al., 2014; Ludwig et al., 2010). Cameron (2007) reviewed attempts by high-risk industries to improve safety behaviour with safety feedback. Feedback presented through written notes or publicly-displayed graphs to either employees or supervisors ultimately improved workplace safety in all instances through either increased observed safe behaviours (e.g., PPE use, housekeeping, tool and equipment use, etc.), decreased hazards (e.g., fire, mechanical, electrical, etc.), or reduced injury rate (Cameron, 2007).

Combining goal setting with feedback. The effects of feedback interventions on workplace safety might be optimized by simultaneously setting safety-related goals. This combination was tested in a feedback-goal intervention targeting the performance of professional drivers in Australia (Newnam, Lewis, & Warmerdam, 2014). The intervention involved three components: (1) weekly meetings between researchers and participants to cooperatively set speed reduction goals; (2) three-week programs of using

feedback of speeding (vocalization of the speed limit, increase use of highway cruise control); (3) weekly updates sent to participants stating their over-speed rate (i.e., ratio of time spent speeding to total drive time) compared to one another. Vehicle GPS data revealed that 75% of participants significantly reduced their over-speed rate from baseline measurements during the three-week program, indicating that a combination of feedback and goal-setting increases safe behaviour. This finding coincides with several studies in high-risk industries (e.g., agriculture, metal working, etc.) that found a combination of feedback and goal-setting to improve workplace safety beyond what either approach could reach alone (Cameron, 2007). Similar results were obtained in a study of pizza delivery drivers (Ludwig et al., 2010) (see next section).

Individual vs. group feedback. The distinction between feedback targets (i.e., worksites and work crews) is an important consideration when using feedback. Ludwig et al. (2010) covertly recorded safe behaviours of U.S. pizza delivery drivers following group vs. individual feedback. Turn-signal use was recorded after implementing a weekly-updated in-store poster displaying the average turn-signal use rate of employees alongside a goal rate. After four weeks of this first phase, in a second phase researchers added individual feedback (i.e., turn-signal use of each driver) to the workplace poster. Post-intervention results showed a significant increase in turn-signal use in a little over half of participants following group feedback and a significant increase in almost all remaining participants following the individual-feedback phase. These results suggest that an individual approach can instigate behavioural change in those unaffected by a group approach (Ludwig et al., 2010). Although the researchers did not measure the isolated contribution of each feedback level, a combination of levels achieved the greatest degree of safety. Thus, presenting feedback information at both the group and individual level reaches a larger audience than either approach alone (Ludwig et al., 2010).

Feedback to Supervisors. Although workers are often the object of feedback interventions, targeting supervisors can also lead to improved workplace safety. Zohar and Polachek (2014) asked manufacturing industry employees to rate the focus placed by their supervisors on three workplace variables: (1) safety and reliability (e.g., error prevention), (2) speed and efficiency, and (3) team communication and coordination. Supervisors then received two individual feedback sessions (six weeks apart) in which the assessment results were discussed and goals were cooperatively set regarding the three variables. Post-intervention results indicated that, compared to baseline and a control group, supervisors in the intervention group significantly shifted their focus toward error prevention and teamwork and away from speed and efficiency. Consequently, employees reported a significant improvement in safety climate and teamwork. These results are in agreement with a report of improved air quality and increased safe behaviours in a chemical factory following feedback to supervisors (Cameron, 2007).

Contrarily, feedback to supervisors was shown no effect on safety culture in a U.S. military archival analysis. MacFadden (2011) found in three years of military survey data that the safety culture of studied army units did not change following one-on-one feedback sessions with unit commanders regarding unit members' safety perception. Additionally, significantly more accidents were reported following feedback sessions compared to baseline assessment. Although this finding might indicate that feedback lead to increased accident rates, it could also indicate underreporting during baseline or

increased accident salience following the feedback sessions. Unfortunately, the archival data contain no record of countermeasures taken by commanders in response to feedback sessions, presenting the possibility that some commanders made no changes, which would have severely skewed results. Although the findings for feedback to supervisors are not as strong as feedback to employees, the current literature suggests it can improve safety-related variables such as safety climate and teamwork.

One type of feedback approach, the token reward system, has also been shown to increase workplace safety, although it can encourage underreporting of incidents (Cameron, 2007).

Visual feedback. Four articles were related to the influence of visual feedback on safety. Visual feedback presents performance data through visual stimuli, which are of three distinct types: visual feedback technology (LED lights and on-screen avatars), text-based feedback, and graphical feedback (graphs and charts). Hartwig and Windel (2013) studied whether visual feedback technology could increase PPE use. The study tasked participants with building 10 electrical circuits by following an instruction manual and offered a $6 bonus for fast performance (in reality, each participant received the same remuneration). Performance was hampered by insulated gloves (i.e., PPE) that participants were asked to wear in order to avoid an electric shock. Participants received periodic feedback on a nearby digital screen in the form of text (i.e., "gloves used" vs. "please wear gloves"), traffic light (a green or red light), or on-screen avatar (a virtual human displaying either joy or sadness/anger). After participants had built 30% of circuits, they received a message that they were performing slower than the average time, meant to tempt them into removing their PPE. A hidden researcher recorded PPE violations of each participant. Results revealed no significant difference between a control group and participants in the text condition but significantly less violations (approximately 60%) in groups receiving feedback with visual (i.e., traffic light) or visual-humanistic (i.e., on-screen avatar) components, compared to the control group. Interestingly, participants reduced violations even when they believed it would forfeit their financial bonus. This finding suggests the potential of visual feedback technology to function beyond a text-based reminder. Future research is needed to validate this hypothesis.

Use of visual feedback technology to enhance workplace safety is also supported in a study involving American coal miners. Steiner et al. (2013) focused on improving the safety of roof bolter machine operators, cited by the authors as particularly hazardous due to confined work spaces and close proximity to moving machine parts. Study participants operated a genuine Fletcher roof bolter in a simulated underground mine environment. Visual feedback was added to the machine in two forms: (1) two LED lights activated by slight lever pressure signified direction of machine component movement (e.g., boom swing) and (2) the six machine levers were shape coded (i.e., each lever given a distinct shape) to visually signify function. Results showed that shape coding can be helpful in reducing selection errors (i.e., selecting an unintended lever), especially in training new employees, as long as coding is applied consistently across machines. However, directional LED lights did not significantly reduce directional errors (i.e., moving a machine part in an unintended direction). Controlling for directional errors is critical as they are relatively common—69% of participants reported committing them at work (Steiner et al., 2013). Despite the insignificant reduction in directional errors, the LED lights were rated in participant interviews as helpful in machine operation. Of the nine interviewed miners in the LED

condition, 78% reported the lights helpful in choosing the correct machine direction or correcting directional error and 100% reported the lights would be useful to them at work. The researchers suggest that light feedback is most helpful in increasing attention to the timing and physical surroundings of the task at hand (Steiner et al., 2013).

Graphical feedback provides an attractive alternative to a LED-light method to improve workplace safety. In a systematic review of feedback interventions, Baker (1998) reported several studies that recorded increases in safe behaviours following placement of a public graph in the workplace that stated the percentage of observed safe behaviours compared to an obtainable goal. This is similar to the driver intervention employed by Ludwig et al. (2010) discussed earlier, which also resulted in increased safe workplace behaviours. Graphical feedback has also been implicated in reducing observed fire hazards on a mine site to zero over 10 consecutive months, although the details of this particular study were only vaguely summarized (Cameron, 2007). Thus, support for graphical feedback interventions comes from a variety of research designs, though it is backed by a limited amount of recent original research.

Specificity of feedback and feedback generalization. Two articles were related to feedback generalization, a situation when feedback is given to alter a target behaviour, yet it inadvertently affects related non-target behaviours (Lee et al., 2014; Ludwig et al., 2010). To illustrate feedback generalization, consider the evaluation of a feedback program implemented in South Korea's construction industry (Lee et al., 2014). Workers received feedback (safety reports accompanied with either verbal praise or constructive criticism) during safety meetings twice per week for four target behaviours: PPE use, housekeeping, driving in work zones, and parking in work zones. After two months, observational data revealed an increase in all four target behaviours as well as two non-target behaviours: cleanup and use of signage during hazardous operations. It is thought that feedback generalization occurs because evaluating individuals on a particular set of behaviours draws their attention to a wider range of relevant behaviours (Lee et al., 2014).

Lee et al. (2014) also explored whether there was a difference between the effects of global feedback (i.e., overall assessment of several behaviours) and specific feedback (i.e., assessment of a single behaviour) on either generalization or safety performance. Global feedback was given to workers as one average safety percentage to represent all four target behaviours, while specific feedback was later given as a safety percentage for each target behaviour. Although both forms of feedback increased safe behaviours equally, global feedback appeared to produce a stronger generalization effect.

Though unintended, the previously described driving study by Ludwig et al. (2014) fits the criteria for specific feedback (i.e., one score given for turn-signal use). As such, this study suggests that specific feedback can create a generalization effect (i.e., increased seat-belt use and complete stops at intersections). However, there was no global feedback in this study for comparison, leading the current literature to favour global feedback due to its larger effect on safety behaviour in a comparative study (i.e., Lee et al., 2014).

Potential issues of feedback interventions. Four articles discussed potential issues with feedback interventions. Despite an overwhelming support of feedback interventions, they are not flawless (e.g.,

MacFadden, 2011). The most common issue among feedback interventions appears to be premature program termination, which results in the dissipation of previously-gained safety benefits, occasionally back to baseline levels (Cameron, 2007; Ludwig et al., 2010; Okinaka & Shimazaki, 2011). Results are mixed regarding whether improved safety will persevere if feedback ends (Baker, 1998). Baker (1998) found workplace errors were reduced following a feedback intervention for lift truck operators, with effects not only persisting, but further reducing three months after the intervention had stopped. Another study described increased earplug use sustained five months following a personal health feedback program (Baker, 1998). However, Baker also describes two instances where safe workplace behaviours, which initially increased following program implementation, significantly dropped following program termination, in one case returning to baseline level. A feedback approach for cyclists at a Japanese university campus found that feedback regarding sidewalk safety was associated with more riders disembarking to walk their bicycle (Okinaka & Shimazaki, 2011). However, rider disembarkment returned to baseline rate once the feedback was stopped. Similar results were obtained from the previously discussed driver study by Ludwig et al. (2010), where turn-signal use had significantly dropped 5.5 weeks after safety feedback ended. According to operant conditioning theory, the benefits of feedback interventions may dissipate following program termination because of a psychological phenomenon known as extinction (Gleitman, Reisberg, & Gross, 2007). According to operant conditioning, behaviour is changed through reinforcement such as feedback. When reinforcement (positive feedback) no longer follows the target behaviour, the frequency of the behaviour can diminish or cease completely, known as extinction. Although continuous interventions demand organizational resources, the current literature suggests continuity is necessary in order to maintain positive effects of feedback interventions (i.e., prevent extinction). However, organizations should allocate resources to additional safety measures because feedback programs tend to focus on only the most prevalent incidents or behaviours, potentially leaving insufficient attention for rare (but still hazardous) occurrences (Cameron, 2007).

Discussion

Evidence suggests that feedback is likely to bolster workplace safety whether used as a standalone procedure or intervention component. Successful feedback interventions grow largely out of an effective interplay between pertinent feedback variables such as program duration, target population (e.g., worker, supervisor, etc.), scope of feedback (e.g., individual vs. group, specific vs. global, etc.), and feedback format (e.g., verbal, written, graphical, technological, etc.).

Gaps in the literature. Although three articles within this chapter discussed formal evaluations of existing feedback-based programs, the majority reported experimental studies conducted in a lab or self-report surveys. Thus, additional research on existing programs in real work settings, especially the mining industry, are needed to enhance external validity. In addition, the current body of literature discusses several forms of feedback (e.g., supervisor walk arounds, weekly meetings, personal emails, written reports, etc.) but does not examine which application is most effective in improving workplace safety.

Recommendations. According to the current scoping review, the general success and versatility of feedback creates many opportunities to improve the safety of organizations. Feedback involves simply

providing a particular target audience (e.g., front-line workers) with performance data regarding a chosen behaviour (e.g., PPE use). However, feedback becomes more complex when choosing the audience and behaviour to target, as well as other factors that influence intervention success (e.g., group vs. individual feedback, global vs. specific feedback, etc.). The current scoping review indicates that future efforts should include an integration of the following feedback strategies:

- **Set goals for performance before giving feedback**. In implementing a feedback program, consider including goal-setting practices as this combination improves workplace safety beyond either of them implemented alone (Cameron, 2007). For example, a public "safety score board" could be implemented at head office or online displaying a *goal* safety score representative of optimal safety calculated from variables such as injury rates and observed safety-related behaviours, and weekly-updated scores (*feedback*) for each work site.
- **Include both group and individual feedback**. When possible, give feedback at both the group and individual levels as a combination of both increases safe behaviours beyond group or individual feedback alone (Ludwig et al., 2010). For example, the above "safety score board" concept could provide scores for each work site (group feedback) and work crew (individual feedback); calculating scores for individual workers would likely be too resource-intensive.
- **Include global feedback**. In providing feedback, include global feedback to evoke a generalization effect (Lee et al., 2014; Ludwig et al., 2010). For example, work crews could be provided with an average rating encompassing several related behaviours—such as PPE use, appropriate clothing (e.g., no rips or loose fabric, etc.), and full body cover (i.e., no bare skin)—which would likely encourage the crew to not only improve on these target behaviours but also on associated non-target behaviours (e.g., application of guards to moving machine parts). Providing specific feedback (one rating for each behaviour) is also useful (Ludwig et al., 2010) but evidence suggests global feedback is more likely to exhibit a generalization effect (Lee et al., 2014).
- **Implement feedback programs on a continuous basis.** When feedback programs are implemented on a temporary basis the positive effects gained while the program is active tend to decline following program termination (Cameron, 2007; Ludwig et al., 2010; Okinaka & Shimazaki, 2011). To prevent this from happening, implement programs on a continuous basis.
- **Make feedback one of many safety programs.** Feedback programs tend to focus on only the most prevalent incidents or behaviours (Cameron, 2007). Thus, additional safety measures should be implemented in order to ensure all safety issues are addressed.
- **With feedback interventions, target both front-line workers and supervisors.** Providing supervisors with feedback on their communication and performance can increase teamwork and safety climate (Zohar & Polachek, 2014) but additional steps are likely needed to improve safety culture (MacFadden, 2011). Research on providing front-line workers with feedback has received more attention in the literature and achieved more positive results (e.g. Cameron, 2007; Cheah et al., 2012; Baker, 1998; Ludwig et al., 2010; Newnam et al., 2014; Spiegel et al., 2010).
- **Utilize visual feedback methods.** Adding visual feedback technology to computer interfaces (e.g., red light to indicate hazardous operations in progress; green light to indicate safe work area) or

machinery (e.g., activation of directional LEDs with light hand pressure on machine controls, giving users a brief adjustment period prior to actual machinery movement) could reduce unsafe employee behaviours (Hartwig & Windel, 2013) and is likely to aid in mistake correction and work performance (Steiner et al., 2013). Similarly, graphical feedback (e.g., a safety performance report that includes graphs illustrating both current and ideal safe behaviour rates) tends to increase safe behaviours (Baker, 1998; Ludwig et al., 2010).

- **Use token reward systems with caution.** Feedback can be relayed through a token reward system (e.g., offering awards or items for x injury-free work hours) to increase safe behaviours and decrease workplace injuries but caution must be given because token reward systems can encourage underreporting of accidents (see Topic 2.1.1.).

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