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A Behavioral Approach to Occupational Safety: Pinpointing and Reinforcing Safe Performance in a Food Manufacturing Plant

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The behavior analysis approach was used to improve worker safety in two departments in a food manufacturing plant. Desired safety practices were identified, permitting construction of observational codes suitable for observing workers' on-the-job performance over a 25-week period of time. The intervention consisted of an explanation and visual presentation of the desired behaviors, as well as frequent, low-cost reinforcement in the form of feedback. A within-subject (multiple baseline) design was used. Employees in the two departments substantially improved their safety performance from 70% and 78% to 96% and 99%, respectively, after the staggered introduction of the program. During the reversal phase, performance returned to baseline (71% and 72%). It was concluded that the intervention, particularly the frequent feedback, was effective in improving safety performance. Not only did employees react favorably to the program, but the company was later able to maintain the program with a continuing decline in the injury frequency rate. The results suggest that behaviorally defining and positively reinforcing safe practices is a viable approach to occupational accident reduction.

Occupational safety has been a frequent and continuing topic of concern with humanitarian, economic, and, recently, legal (Williams-Steiger Occupational Safety and Health Act of 1970) implications. Although accidental work deaths have been reduced significantly, the annual toll of occupational accidents in the United States still includes approximately 12,500 deaths and 2,200,000 disabling injuries (National Safety Council, 1977).

Psychological studies in the safety field are primarily descriptive. Many studies focus on the relationship between accidents and factors that are, from the standpoint of management, difficult to alter, for example, age, experience level, and personality characteristics of the work force (Crawford, 1960; Davids & Mahoney, 1957; Harris, 1950; Keenan, Kerr, & Sherman, 1951; Kerr, 1957; Mintz & Blum, 1949; Van Zelst, 1954; Verhaegen, Vanhalst, Derijcke, & Van Hoecke, 1976). Other studies identify factors important to the functioning of an effective safety program. These studies include the compiling of suggestions of industrial safety experts and supervisory personnel (Planek, Driessen, & Vilardo, 1967), the description of safety activities by award-winning companies (Davis & Stahl, 1964; National Safety Council, 1969), and the comparison of safety efforts of high- and low-accident firms matched for type of industry, size, and geographical location (Cohen, Smith, & Cohen, 1975; Shafai-Sahrai, 1971; Simonds, 1973). Although these studies are important initial steps, the conclusions that can be drawn from them are limited. It is not clear, for example, whether the presence or

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absence of such recommended activities as the employment of safety officials in top management positions and the discussion of safety in plant publications are a cause or an effect of accident rates.

While the importance of safety remains undisputed, a review of the literature reveals a paucity of well-controlled studies demonstrating the efficacy of safety programs implemented in work settings. More often than not, well-controlled studies are reported in simulated work settings (McKelvey, Engen, & Peck, 1973; Rubinsky & Smith, 1973). Inhouse safety programs are notable for their lack of systematic assessment (cf. Laner & Sell, 1960). Of the accounts that have been reported in trade journals such as *Job Safety and Health, National Safety News, Factory, Occupational Hazards, Iron Age,* and *Personnel,* the evidence is primarily anecdotal. Following a review of the literature, Ellis (1975) concluded that "the quality and intensity of research necessary to draw firm conclusions. . . were found to be remarkably inadequate" (p. 180).

On those occasions in which attempts have been made to evaluate safety efforts (e.g., Winget, 1975), assessments typically are made only before and after the program. Although a before and after comparison is better than no comparison at all, it alone is not sufficient (Campbell & Stanley, 1963). Even if improvements are shown, it cannot be concluded that the change is responsible for the improvements. Other plausible alternatives (e.g., history, maturation, statistical regression) need to be ruled out. One of the reasons that safety programs may be evaluated so rarely is the difficulty involved in implementing group designs. Although group designs are widely acknowledged to be *the* way to rule out alternative hypotheses, suitable control groups are difficult to arrange in work settings. Rarely can one randomly assign persons to different groups with the purpose of exposing only one of the groups to the change. When using intact groups as comparison groups, the groups frequently differ from one another in important ways. Other evaluation techniques are needed to overcome these design problems when assessing the effectiveness of in-house safety programs.

Another methodological problem involves the criterion measures used: (a) disabling injuries (commonly referred to as lost-time accidents) and (b) medical treatment injuries (Grimaldi, 1970; Jacobs, 1970; Rockwell, 1959; Tarrants, 1970). Lost-time accidents, which include deaths, permanent total disabilities, permanent partial disabilities, and temporary total disabilities, are what statisticians commonly describe as "rare events." In the plant described in the present study, there was an average of less than one lost-time accident per month for the year preceding the study. Within one 5-month period, no lost-time accidents occurred, whereas in 1 month four occurred. Because of the infrequent and unpredictable occurrence of lost-time accidents, it is difficult to reflect the effect of a safety program, using lost-time accidents as the primary index. Medical treatment injuries, which include first-aid cases and those injuries that do not qualify as disabling but require the services of a doctor, are particularly subject to large-scale reporting and recording inaccuracies, thereby resulting in a measure of questionable reliability. If a decline in medical aid injuries is reported, it is often not clear whether this type of injury actually decreased, whether injuries were reported less often, or whether persons' perceptions shifted. Another problem is that both are after-the-fact measures and, as a result, say little about what can be done to stem reoccurrences. If a measurement system can be devised that identifies contributing factors, then positive steps can be taken by both management and workers.

Numerous approaches have been suggested to improve safety, ranging from transactional analysis ("Transactional Analysis," 1975) to improved selection techniques and job redesign (Chaffin, 1974). Traditional safety efforts focus on the engineering or educational aspects of safety (Anderson, 1975; Grimaldi & Simonds, 1975). However, relatively few accidents (10%) are considered to be the result of unsafe mechanical or physical conditions (e.g., inadequate guards, unsafely designed machines). In reviewing accident files, Heinrich (1950) and others found that the overwhelming number of accidents were a function of unsafe acts on the part of workers (e.g., failure to use protective devices, making safety devices inoperative). Safety training, an integral prerequisite, seems to be only part of the solution. Recent evidence suggests that the communication of rules and regulations alone is not sufficient to maintain performance unless employees come into contact with the appropriate reinforcement contingencies (Pierce & Risley, 1974; Quilitch, 1975).

The field of applied behavior analysis (or behavior modification) has been identified as an approach with direct application in the area of occupational safety (Bird & Schlesinger, 1970; McIntire & White, 1975; Smith, Note 1). The behavioral approach not only emphasizes the pinpointing of desired performance but also provides a positive means of motivating workers to perform in a consistently safe manner. Instead of aversive control techniques, workers are positively reinforced for performing safely. Informational (feedback, self-recording), social (praise, recognition), and tangible reinforcers (trading stamps, cash bonuses) have been used as well as nonmonetary privileges. While it is important to control physical conditions within the work environment and to instruct and remind employees about potential hazards, the importance of worker motivation should not be overlooked.

Other promising contributions of the behavioral approach are in the areas of evaluation and measurement. Within-subject research designs frequently used by persons in the area of behavior analysis can be readily adapted to the evaluation of safety programs (Baer, Wolf, & Risley, 1968; Hersen & Barlow, 1976; Kazdin, 1973; Komaki, 1977). By pinpointing desired behavior, in this case safe performance, one can not only have a more sensitive measure of the safety level within an organization but one can also clarify and positively reinforce those behaviors, thus increasing their likelihood of reoccurrence.

Earlier studies have demonstrated the usefulness of the behavioral approach in areas such as absenteeism (Kempen & Hall, 1977; Pedalino & Gamboa, 1974), punctuality (Hermann, de Montes, Dominguez, Montes, & Hopkins, 1973), on-the-job performance (Komaki, Waddell, & Pearce, 1977), and accident reduction (Brethower & Rummler, 1966; Smith, Anger, & Uslan, in press; Fox, Note 2; Ritschl, Mirman, Sigler, & Hall, Note 3). Unfortunately, the reports in the area of safety were limited by the scope of worker safety practices considered, and/or they were flawed methodologically by the lack of controls or implementation problems during the evaluation phase.

In the present study a behavioral approach was used to improve safety practices in a food manufacturing plant. Instead of relying on the traditional indices, a direct observational technique emphasizing a variety of safe practices was used. Workers were positively reinforced for performing safely. A within-subject design was employed to evaluate the effectiveness of the program.

Method

Subjects and Setting

This study was conducted in a wholesale bakery that makes up, wraps, and transports pastry products to retail outlets nationwide. Prior to the study, both the bakery division president and the plant manager had identified safety as their primary concern, and both were receptive to the idea of a positively based safety program. Because of a dramatic increase in the injury frequency rate (number of disabling injuries per million hours worked) and a corresponding rise in Workman's Compensation premiums, plant personnel had become increasingly concerned. During a 3-year period (1971–1973), the injury frequency rate was more or less stable at 35.02. For the year preceding the present study, the rate dramatically increased (by 53%) to 53.8. Considering that the injury frequency rate for the bakery industry as a whole is less than 20, the fact that frequency rates rarely exceed 35 for such hazardous occupations as underground mining and meat packing, and that industries with inherently hazardous operations (e.g., automobile, steel) report frequency rates of less than 5 (National Safety Council, 1977), the concern of management was not unwarranted.

The plant is located downtown in a metropolitan city in the southeastern portion of the U.S. Depending on production schedules, the plant operates one to two 8-hour to 10-hour shifts, 4–7 days a week. Annual sales average $11,000,000 (39,000,000 units).

Out of a total of 162 employees, 142 are directly involved in the preparation of baked goods. Workers range in age from 17 to 64 years, with a mean age of 31.8 years; the mean seniority level is 7.9 years, with a range of from less than 6 months to 15 years. With the exception of supervisory personnel, the workers belong to the Teamsters Union. Annual wages and salaries for line personnel and supervisors range from $7,600 to $14,300.

The second-shift makeup and wrapping departments were selected because of the high proportion of accidents that had occurred in these departments during the previous year. Of the total number of accidents reported plantwide, almost half—19 out of 39—occurred in these departments. Personnel on the second shift were selected because over two thirds of the above accidents involved employees on the later shift: 8 out of 10 for the makeup department and 6 out of 9 for the wrapping department. Several reasons were suggested for the higher proportion of accidents during the second shift: The work area was in greater disarray following a full work day and there were less experienced workers and supervisors.

The second-shift makeup department is composed of 16 workers, 7 females and 9 males, and a male supervisor. In the wrapping department there are 22 employees, 15 females and 7 males, and a male supervisor.

In the makeup department the ingredients are measured and mixed; the dough is rolled, floured, sectioned, and placed manually into baking pans. After the pans are conveyed on a series of belts to the oven and cooling racks, the finished pastries are manually depanned and packaged. In the wrapping department the packages are bagged, sealed, and labeled; cartons are assembled, packed, taped, and stacked on skids ready to be shipped. Equipment includes two types of mixers (dough and smear), an extruder and anets machine, and bagging, sealing, and labeling machines. With the exception of workers (primarily female) who remain more or less stationary on the line, the employees move freely within their respective departments as they carry out their duties. An employee in the makeup department, for example, may be involved in measuring ingredients, placing them in the dough trough for mixing, and transferring dough to and from the rising room and into the extruder.

Baseline Analysis

Previous safety efforts were ascertained and the causes of previous injuries were assessed. New hires received no formalized safety training. On a day-to-day basis, safety was rarely mentioned. The only reminders were commercial safety posters at the entrance to the work area and a bulletin board in the employee dining facility on which accident information (e.g., date since the last lost-time accident) was posted irregularly. At the beginning of the study the bulletin board had not been updated in the last 6 months. No single person was responsible for safety. The management-level person responsible for compiling the accident data traveled frequently between plants and had little, if any, contact with supervisors or workers. The plant manager had recently appointed a new safety committee composed of the second-shift supervisor and four on-line workers; they rarely met, however. Throughout the entire period of the study, there were no plant-wide safety meetings.

Equipment within the plant was determined to be in good order. One month prior to the study, a mock Occupational Safety and Health Association inspection was conducted by the insurance company. Upon receiving the report, the plant maintenance department corrected the items that had been noted.

After it was found that earlier safety efforts had been spotty and fragmented and that relatively few accidents occurred because of machine malfunctions or errors in design, attention shifted to employee actions. A behavioral analysis, that is, an assessment of the consequences of desired and undesired behaviors, was conducted to determine what might be maintaining unsafe practices and hindering safe acts. The behavioral analysis revealed that safe practices were probably not being maintained because there was little, if any, positive reinforcement for performing safely. Little or nothing was said or done by management or co-workers when employees took the time to act in a safe manner. At the same time, employees were not provided with opportunities to learn to avoid unsafe practices. When employees did perform unsafely, they rarely (relative to the number of unsafe acts) experienced an injury.

Measure

An observational code was designed to measure the safety level. To pinpoint safety items, accident reports were reviewed to detail the types and circumstances of previous (3 years) injuries and supervisors were encouraged to contribute items. Each observational code was tailored to reflect the differences in departmental tasks and previous accidents. Because of the diversity of previous accidents, it was not possible to limit items to any one category, such as the wearing of protective equipment. In the wrapping department there were a total of 15 different items; in the makeup department there were 20. Only three items were common to both (Table 1).

Instead of using vague phrases such as being more careful or less rushed, each item was clearly defined. A liquid spill, for example, was defined as any liquid accumulation in excess of 20 cm in diameter and 1 mm deep. In addition, the observational code was field tested prior to data collection to eliminate ambiguities in interpretation. For items with a tangible result, an outcome measure (e.g., cardboard spacers on the floor) was used rather than the behavior (e.g., dropping spacers).

During a 55-min. observation period, a trained rater, in full view of the workers, observed four different areas in the makeup department (35 min.)

Table 1
Sample Items on Observational Codes

Makeup department
When picking up pans from the conveyor belt, no more than two pans are picked up prior to placing the pans on the pan rack.
Roll pans are stacked no higher than the rear rail of the pan rack.
When lifting or lowering dough trough, hand holds and at no time loses contact with dump chain.
When pulling dough trough away from dough mixer, hands are placed on the front rail of the dough trough and not on the side rails.
Wrapping department
There are no cardboard spacers (defined as cardboard 30 mm square or larger) on the floor.
When cutting wire bands from stacks of boxes or spacers, employee cuts with one hand and holds the metal strap above the cut with the other hand.
When moving conveyor, at least one person is on each end.
When handling a skid, employee attempts to break its fall in some manner, for example, sliding it off rather than letting it fall flat on the floor.
Both departments
When mechanical problems arise (e.g., pans jam on conveyor belt, belt breaks), the machine is turned off (the machine is off when the on–off switch is in the off position and machine moving parts have stopped) or maintenance is notified.

and two areas in the wrapping department (20 min.). Using the observational code, each item was checked as safe, unsafe, or not observed. Any time an item was performed unsafely, it was recorded as "unsafe" regardless of the number of times it had been performed safely. Observations were conducted on the average of four days a week. The exact times varied throughout the shift; no observation was carried out at the same time of day on any two consecutive visits. To compute the percentage of items performed safely by the group, the number of safe items was divided by the total observed, and that figure was multiplied by 100.

Interrater reliability was assessed on a weekly basis, for an average of one reliability check every 4.1 observations. Another person independently recorded at the same time, using the same observational technique as the primary observer. To compute interrater reliability, the percentage agreement method was used. The number of agreements was divided by the number of agreements plus any disagreements and then multiplied by 100. An agreement was tallied when both raters categorized an item in an identical manner. The raters consistently agreed. Reliability averaged 97.4% agreement for the makeup department and 99.6% agreement for the wrapping department. To assess the likelihood that the changes resulted from observer bias, persons who were unaware of the timing of the interventions independently recorded during Sessions 17, 28, and 35. Agreement between the primary rater and the unbiased observer was consistently high. In the wrapping department, there was complete (100%) agreement; in the makeup department reliability averaged 96.7%. As a result, it was concluded that the changes were not likely to be a function of observer bias.

Intervention

The intervention consisted of a training component in which employees were presented with safety information and a motivational component in which employees were reinforced for desired behaviors. On the first day of the intervention, employees were released from their regular work assignments for one 30-min. session. Following a brief introduction, employees were shown pairs of slides (35-mm transparencies) corresponding to items on the observational code. All of the scenes were staged in the plant during the first shift with equipment normally used in everyday operation. First-shift employees posed as they performed selected incidents safely and unsafely. In one transparency, the first-shift wrapping supervisor was shown climbing over a conveyor; the parallel slide illustrated the supervisor walking around the conveyor. After viewing an unsafe act, employees were asked to describe verbally what was wrong ("What's unsafe here?"). When the problem had been pointed out, the same incident was shown performed in a safe manner and the safe-conduct rule was explicitly stated ("Go around, not over or under conveyors"). Employees were then shown a list of reminders of the safety points just illustrated. Special attention was drawn to those items that had been performed unsafely over 40% of the time during baseline.

At the conclusion of the presentation, the employees were shown a graph, measuring approximately 27 × 36 inches (70 × 90 cm), with their baseline data and an unplotted portion labeled "Intervention." The fact that they had been performing safely over two thirds of the time was emphasized; examples were given of safe acts they did consistently. Then employees were encouraged to consider increasing their performance for the following rationales: their own protection, to decrease costs for the company, and, lastly, to help the plant get out of last place in the safety ranking of the parent company. A departmental goal of 90% was suggested and agreed to by the employees. Then employees were told that they would be given information about their safety performance and that it would be posted on the graph for all to see.

Immediately after the presentation, the graph and the list of safety reminders were posted in a conspicuous place within the employees' working area.

Thereafter, whenever observers collected data, they posted on the graph the percentage of incidents performed safely by the group as a whole (data for individuals were not collected), thus providing the workers feedback on their safety performance. Since the 90% level had been demarcated on the graph, it was readily apparent when the departmental goal had been achieved.

In addition to feedback, another planned component of the intervention was for supervisors to recognize workers when they performed selected incidents safely. Each supervisor was to comment specifically when he saw an employee performing safely. Several examples were demonstrated. Throughout the intervention each supervisor was requested to fill out a checklist indicating how often ("always, sometimes, never, did not observe") he had commented when he saw a worker engaged in one of five selected incidents each day. The incidents chosen were those that had most often occurred unsafely during baseline, for example, turning the machine off before cleaning the heat sealer.

To ensure the participation of the supervisors, the president and the plant manager were asked to talk with each supervisor about the safety program at least once each week. Both were also asked to fill out a similar checklist indicating when they had spoken with the supervisors.

Procedures and Design

A multiple-baseline design was used. Baseline data were collected in two departments. After 5½ weeks (19 observation sessions), the intervention was introduced in the wrapping department. After 13½ weeks (49 observation sessions), the intervention was started for the makeup department. Data continued to be collected.

When the intervention had been in effect for 11 and 3 weeks (61 sessions) in the wrapping and makeup departments, respectively, a reversal phase was instituted. The observers discontinued observing and providing feedback. The list of safety reminders remained in each department along with the graph of their previous performance during baseline and intervention phases. To assess the effect of the reversal phase, observations were reinstituted 5 weeks later on the average of once a week for 4 weeks (Sessions 62–65). The raters observed as they had done during the previous two phases but did not post data on the graphs.

Results

Safety Level

Data were collected for a total of 65 sessions over a 25-week period of time. Figure 1 shows the percentage of incidents performed safely during each observation session. Summary data for the two departments during baseline, intervention, and reversal phases are presented in Table 2.

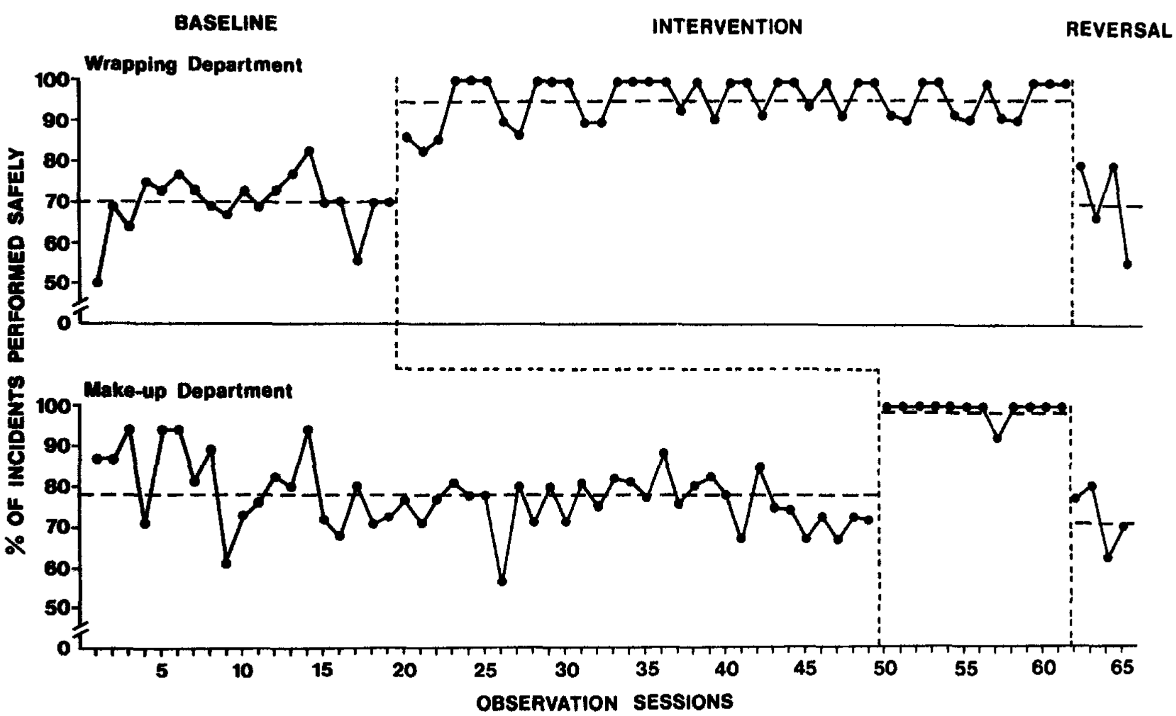

Figure 1. Percentage of items performed safely by employees in two departments of a food manufacturing plant during a 25-week period of time.

Table 2
Safety Level During Baseline, Intervention, and Reversal Phases

Department	Phase	M[a]	Observation sessions	Duration (in weeks)
Wrapping	Baseline	70.0	1–19	5.5
	Intervention	95.8	20–61	11
	Reversal	70.8	62–65	8.5
Makeup	Baseline	77.6	1–49	13.5
	Intervention	99.3	50–61	3
	Reversal	72.3	62–65	8.5

[a] Percentage of incidents performed safely/number of sessions.

During baseline, employees were performing safely at least two thirds of the time as evidenced by baseline means of 70.0% and 77.6% for the wrapping and makeup departments, respectively. In the wrapping department, performance never exceeded 90%, the highest score being 83%; in the makeup department, scores exceeded 90% only four times out of 49 sessions.

Following the intervention in the wrapping department, the percentage of incidents performed safely increased dramatically. By the first week, the department had obtained their first 100% score. After the second week, the department was obtaining scores of at least 90% regularly. During the entire intervention, no score fell below 83%, the highest score during baseline, and over half of the time the department obtained 100% scores. In contrast, in the makeup department, which remained under baseline conditions during the same period (Sessions 20–49), no improvements were noted. Performance remained more or less at its baseline rate. Following the intervention in the makeup department, however, scores immediately rose to 100% and, with one exception, continued at this level. The intervention mean for the makeup department was 99.3%.

During the reversal phase, performance returned to baseline levels. In the wrapping department the percentage of incidents performed safely fell to an average of 70.8%, whereas in the makeup department performance declined to an average of 72.3%.

Because the interventions were introduced at different points in time and performance improved only after, and not prior to, the introduction of each intervention, sources of internal invalidity such as history, maturation, and statistical regression were eliminated (Komaki, 1977). It is not likely that another extraneous event would have the same impact in two different departments at two different points in time. If maturation were responsible, performance would be expected to improve as a function of the passage of time; however, improvements occurred only after the introduction of the interventions. The effects of statistical regression were ruled out because regression effects would be seen in any series or repeated measurements and not just after the interventions.

The reversal phase made it possible to assess whether reactivity of measurement was a potential source of confounding. If performance levels were primarily a function of the presence and absence of the observers, then one might expect that performance would continue during the reversal phase at its high intervention rate. Because performance declined to baseline levels during the reversal phase when the observers were not only present but the workers knew what was expected, it is unlikely that the observers alone served as discriminative stimuli for safe performance. As a result it was concluded that reactivity of measurement was not a plausible alternative explanation for the improvements obtained.

Employee Reactions

Although worker responses were not formally solicited, indications were that they were quite favorable. When the first data point of the wrapping department was posted, workers actually clapped and cheered. The graphs, although easily accessible, were never mutilated. In fact, employees carefully drew lines connecting adjacent data points when the observers had neglected to do so. Throughout the intervention, employees continued to express interest. When performance fell below 100%, employees typically asked which item(s) had been counted off and one or more fellow workers were reminded about being safe the next time. Following the intervention in the second department, an informal competition arose. Workers checked to see which department had scored higher.

During the course of the study, no complaints were noted about the presence of the observers. One of the observers, related to the company president, was known by many of the workers since he had worked previously in the plant. Prior to the study the known observer introduced the first and second authors, briefly mentioning their interest in the area of safety. Initially, heads would turn; however, after field-testing the items, the employees hardly seemed to notice the observers.

Supervisory Participation

The supervisors were quite helpful in suggesting items (primarily housekeeping-type items) to be included on the observational code. However, difficulties were encountered in implementing the recognition component of the intervention. Although data were not systematically collected, there was some question about the extent to which the supervisors consistently recognized employees performing safely. If the supervisors were praising workers regularly, it is likely that they would have filled out the recognition checklists. However, only 15% and 54% were turned in by the wrapping and makeup supervisors, respectively. Forgetting or lack of time were the two most frequently offered reasons. Because of the uncertainty about supervisors' comments, the primary change agent was considered to be feedback.

Management Support

Although management continued to give their verbal support, several difficulties arose in implementing the program. There were delays in the scheduling of the interventions, particularly in the makeup department. There were few indications that management was communicating their support to supervisory personnel. Only occasionally did they consult the graphs posted in the departments. On their recognition checklists, which they turned in twice, they noted they were infrequently on site during the second shift.

Maintenance

Difficulties were also encountered in the area of maintenance. Continual suggestions were made about plant personnel learning to observe, record, and post the safety level. Little progress was made, however, until the president saw the results of the reversal phase. Within 2 weeks, an employee was appointed and trained to post data not only for the second but also for the first shift. Thereafter, data were posted by plant personnel on the average of once a week.

Within a year, the injury frequency rate had stabilized at less than 10 lost-time accidents per million hours worked, a relatively low figure. The plant moved from last to first place in the company standings and received a safety plaque from the company "in recognition of successfully working 280,000 hours without a disabling injury" over a period of 10 months.

Discussion

The results of this study illustrate the viability of a behavioral approach to occupational accident prevention. When safety was behaviorally defined and positively reinforced, workers in a wholesale bakery not only reacted favorably to the program but also substantially improved their safety performance. The company was later able to maintain the program with a continuing decline in the injury frequency rate.

Several unique features were generated as a result of using a behavioral approach to safety. By pinpointing the desired behavior, it became clearer to all parties exactly what and how workers should be performing. In place of generalized safety slogans or standardized safety audits, the instructional aids and measurement system reflected the workers' own work environment.

A focus on desired performance had direct implications for the type of change strategy chosen. Instead of concentrating on avoiding an accident, an infrequent occurrence, efforts were placed on motivating workers to perform in a safe manner. The stress on the contingencies of reinforcement is in direct contrast to safety studies that focus on worker traits (e.g., accident proneness) and safety programs that solely rely on controlling physcial conditions or safety training.

The reinforcer used in the present study, feedback, was not costly. In fact, given the magnitude of the consequence, the resulting improvement in performance was substantial. Several reasons are suggested for the effectiveness of the feedback system used (Lawler & Rhode, 1976). First, the feedback provided was positive (focusing on safe performance), objective (as pinpointed on the observational code and recorded by outside observers), and influenceable (in that employees knew how to improve). Second, the suggested standard of 90% was agreed upon by employees and was reasonable in that it allowed for less than perfect performance and reflected their baseline levels of performance. Third, the feedback was provided relatively frequently (on the average of 3–4 times a week) and publicly (making it likely that the results would be known plantwide). Lastly, persons could make comparisons within groups (relative to baseline and the goal) and between groups (following the intervention in the second department), as well as comparisons over time. Although one or more of these dimensions no doubt contributed to the effectiveness of the feedback system used, it would be interesting to assess what dimension or combination of dimensions is the most effective in future studies (see Adam, 1975; Hegarty, 1974; Kim & Hamner, 1976; Nadler, Mirvis, & Cammann, 1976; Panyan, Boozer, & Morris, 1970; "Performance Audit," 1972; Pommer & Streedbeck, 1974, for examples of feedback in organizational settings).

The implementation of a feedback system with its implied threat of evaluation is of frequent concern. In the present study no adverse reactions were noted. One of the reasons for its acceptance may be related to the paucity of positive consequences for safe acts during baseline and the lack of negative sanctions for less than perfect performance during the intervention. Throughout the study the investigators frequently stressed to upper level management how well the departments were performing in spite of the lack of reinforcement.

The reinforcement system employed in the present study differs from most reward systems used in the field of safety. Typically, the emphasis is on the negative, the reduction of accidents, with little guidance about what an individual worker should do to avoid an accident. When desired performance is rewarded, the rewards are so infrequent as to be virtually ineffective. In the plant described in the present study, for example, over a year passed before the plant received a plaque from the parent company. It is not uncommon for safety awards to be delayed as long as 5 years (e.g., U.S. Civil Service Commission, Note 4). Because of the time lags involved, it may be difficult to maintain performance even with a substantial reward.

The present study illustrates the importance of reinforcing persons at all levels of the organization. Supervisors in the present study may not have participated more fully during the intervention because of the level of support demonstrated by upper level management. If management had acknowledged the efforts of supervisors more consistently, then the supervisors might have been less likely to treat the safety program as an ancillary part of their job. An intriguing research area, yet to be fully explored, is the use of behavioral principles in analyzing and motivating supervisory and upper level management.

A component analysis was not carried out in the present study, so it is not possible to determine the relative effectiveness of the informational and the feedback components of the intervention. To determine the impact of safety instruction and awareness more directly, it would be interesting to assess the effect of the presentation of safety information alone. Another research possibility is to determine the effect of feedback alone. In the present study there were indications that employees were already aware of the proper safety rules so feedback alone may be effective in improving performance.

The fact that performance returned to baseline levels during the reversal phase is of considerable interest, particularly since workers had demonstrated that they knew what to do and how to do it. One possibility is what Parsons (Note 5) refers to as an inconvenience factor. By ceasing to perform safely, employees could avoid interposing additional steps in their sequence of performance (e.g., extra movement, circuitous routing). Another related possibility is that workers were reinforced for performing unsafely by the accomplishment of more output. Data were not systematically collected, but there were no indications that productivity fluctuated as a function of the level of safety performance.

The behavioral approach offers methodological as well as substantive contributions to the area of safety research (Bouchard, 1976). The use of a within-subject design, in this case a multiple-baseline design, makes it possible to draw causal conclusions about the efficacy of the intervention without traditional control groups. The reversal phase allowed one to rule out reactivity of measurement as an alternative explanation for the improvements. The observation and recording system employed provides a sensitive and reliable measure of the safety level in the organization. Although a perusal of the accident rates at the end of the year may make it appear as though unsafe behaviors predominated, the repeated measurement of performance makes it possible to objectively judge safety performance. The repeated measurement of performance also makes it possible to quickly determine whether any program is having its desired effect. Instead of waiting until posttest data are analyzed and interpreted, one can quickly introduce alternate strategies, if needed. To the extent that performance is related to the occurrence of accidents, then injuries should decline. Although a correlational analysis was not possible in the present study (no lost-time accidents occurred in the entire plant during baseline, intervention, or reversal phases), it is hoped that assessments of the relationship between a behavioral measure of safety and injuries will be conducted in future studies.

To maximize the probability that the company would take over the program, efforts were made to ensure that the program was acceptable to plant personnel and could be accomplished in a reasonable amount of time. Supervisors and selected workers were asked to suggest, select, and revise items on the observational code. No attempts were made to identify the hazards associated with each step of each job. Only those items that were suggested by plant personnel and/or related to a previous accident were included. As a result the observational codes were kept to a reasonable length and level of complexity.

This study not only illustrates the potential of the behavioral approach in the area of occupational accident prevention but also raises further research questions. The problem with any single study is the lack of external validity. It would be interesting to assess whether a behavioral approach to safety would have a similar effect on employees with different backgrounds and job activities in different types of organizations. Another promising research area would be to explore the effects of safety programs on such organizational concerns as productivity, job satisfaction, and employer–employee relations. Safety programs, not necessarily restricted to behaviorally based programs, would also profit from a cost-effectiveness analysis. Further research is surely warranted.

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