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The effect of workers' visibility on effectiveness of intervention programs: Supervisory-based safety interventions

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Abstract

Introduction: This paper discusses an organizational change intervention program targeting safety behaviors and addresses important considerations concerning the planning of organizational change. Using layout of the plant as a proxy for ease of daily leader-member interaction, the effect of workers' visibility on the effectiveness of supervisory-based safety (SBS) interventions is examined. Through a reinforcement-learning framework, it is suggested that visibility can affect supervisors' incentive to interact with subordinates regarding safety-related issues. *Method:* Data were collected during SBS intervention studies in five manufacturing companies. *Results:* Results suggest a reinforcement cycle model whereby increased visibility generates more frequent exchanges between supervisors and employees, resulting in improved safety behavior among employees. In turn, employees' safer behavior reinforces continued supervisory safety-related interaction. *Conclusion and impact on industry:* Visibility is an important moderator in supervisory based safety interventions, and can serve to increase workplace safety. Implications of these findings for safety are discussed.

Keywords: Supervisory-based safety interventions; Reinforcement learning; Visibility; Ear protection; Safe behavior

1. Introduction

Organizational Health and Safety (OHS) has become an important measure of organizational performance, partly because of the related costs of health and safety to organizations and governments. For example, every year 10 million of the 150 million workers in the European Community are affected by accidents or diseases at work. Compensation costs are estimated at 20 billion euro per year (Boyd, 2003). In the United States, work-related injuries have been estimated at $125 billion per year. Despite being alarmingly high, these costs are thought to be underestimated because of the propensity to under-report in OHS (Pransky, Snyder, Dembe, & Himmelstein, 1999), making actual costs of OHS even higher. Beyond the purely financial considerations are the human ones. In the United States, 17 employees die every day as a result of industrial accidents — a total of 63,589 deaths from 1980-1989 (U.S. Department of Health and Human Services, 1993), at the most conservative estimate. An additional 137 people die from workplace diseases every day, and the number of injuries is much higher. For example, in 1992 alone 3.3 million work-disabling injuries were reported, and some 370,000 employees suffered work-related injuries (Bain, 1997).

The literature suggests two main approaches to reducing OHS costs and improving safety in organizations. The first is safety engineering, which is dominant in the safety field (e.g., Woodside & Kocurek, 1997). Safety engineering concentrates on safe physical environments including mechanical features for accident prevention and other features such as non-slip surfaces, railings, barriers for dangerous mechanical parts, noise insulation, and so forth. Under this approach dealing with safety issues is more of an engineering challenge than a managerial or behavioral concern.

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The second approach is the behavioral approach, which aims to improve safety through tools such as safety training (Cooper & Cotton, 2000; Goldenhar, Moran, & Colligan, 2001; Sinclair et al., 2003), compensation (Stetzer & Hofmann, 1996), and organizational safety behavior interventions (Atkinson, 2000; Williams & Geller, 2000). In these approaches management tries to improve and change organizational safety level by influencing employee behavior rather than by changing the physical setting. For example, in the 'behavioral safety' approach (Geller, 1996; Krispin & Hantula, 1996; McAfee & Winn, 1989) management tries to modify behavior by providing incentives (rewards). These managerial strategies provide an important organizational control mechanism that improves safety performance (Johnson & Gill, 1993; Reason, 1990, 1995; Reason, Parker, & Lawton, 1998). They are also important because most accidents in the workplace have a behavioral component (National Safety Council, 1999).

Most behavioral approaches rely upon dealing directly with the employees (training employees, compensating employees, etc.). However, one recent development of the behavioral approach is the supervisory based safety intervention program for improving safety performance (Zohar, 2002; Zohar & Luria, 2003). Zohar and Luria (2003) demonstrated that intervening at the supervisory level eventually influences employees' behavior as well as safety performance. The current study aims to integrate the engineering approach with the behavioral approach used by Zohar and Luria (2003) to investigate the influences of physical environment (an engineering approach variable) on an organizational intervention (behavioral approach tool). It demonstrates that physical variables can be related to supervisory interactions with subordinates and therefore must be taken into account in safety management.

1.1. Supervisory safety intervention

Aligning supervisory priorities with the strategic priorities of an organization is necessary for successful implementation of organizational safety policies (Zohar & Luria, 2005). However, the necessary conditions for such alignment are not always clear. In 2003, Zohar and Luria presented an intervention program for changing employees' safety behaviors by modifying and aligning supervisory safety priorities, identified as supervision-based safety (SBS) intervention, based on concepts of leadership and manager-development programs.

Supervisory recognition and feedback during daily exchanges between leaders and members are amongst the most powerful incentives at the workplace (Stajkovic & Luthans, 2003), and such exchanges provide the best indications of real priorities at the workplace (as opposed to mere formal declarations), especially concerning competing operational demands such as productivity and safety. As such, they constitute the primary source of climate perceptions (Zohar, 2003), serving as a reliable, socially validated assessment of the kinds of behavior likely to be rewarded and supported both in the organization and in individual sub-units. SBS interventions encourage front-line supervisors to express high safety priorities during daily exchanges with workers (Zohar, 2002; Zohar & Luria, 2003).

The intervention team identified the proportion of safety-related exchanges over time, and provided this information in the form of feedback and coaching to participating supervisors and to their immediate superiors (to improve alignment). The researchers did not directly influence the content or nature of the exchanges, but offered integrated feedback and coaching throughout the intervention by means of individualized bi-weekly sessions with participating supervisors. In order to improve alignment, responsibility for the bi-weekly feedback and coaching was gradually transferred from the research team to the immediate superiors of participating front-line supervisors. Senior management was also involved in the process, providing managers with the same information throughout the intervention, in order to create alignment across the entire organizational hierarchy. The results of a typical project (see Fig. 1) demonstrate the value of the intervention, indicating a synchronized increase in the frequency of safety-related interactions and a decrease in the rates of unsafe behavior when working with electricity, and movement in zones over time.

These interventions demonstrate that rates of unsafe behavior are strongly influenced by supervisory safety-related interaction: when supervisor-subordinate interactions frequently focus on safety, employees behave in a safer manner. Conversely, employees tend to be less careful when supervisors do not interact with them on safety issues. This may be due to melioration bias (Herrnstein, Loewnstein, Prelec, & Vaughan, 1993), which suggests that immediate costs of safe behavior such as slower pace, extra effort, and discomfort are assigned greater weight than low-probability long-term benefits, even though the latter are substantial (i.e., avoiding injury). Supervisory behavior can thus be a key factor in maintaining high safety levels by influencing employees' safety behavior (see also Zohar, 2002).

1.2. Visibility and SBS interventions

Our general purpose is to improve understanding of the conditions influencing effectiveness of supervisory-based safety interventions. To do this, the study seeks to identify situational factors affecting change in supervisory safety-related interactions that are ultimately conducive to safe behavior. Specifically, we evaluate the role of *visibility* (i.e., to what extent the

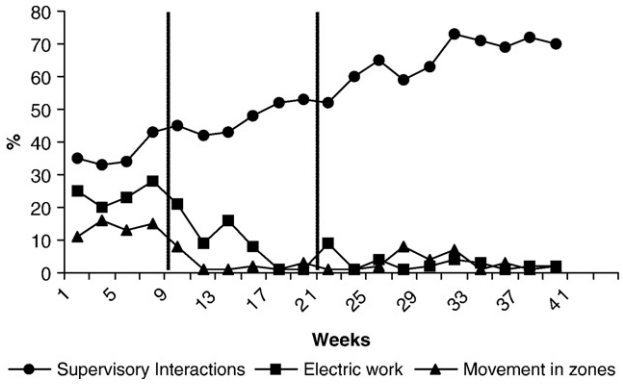

Fig. 1. Demonstration of synchronous change in supervisory safety exchanges and workers' safety behaviors during SBS intervention (Zohar & Luria, 2003).

layout of the department makes it possible and easy for the manager to observe his/her workers' behavior). The layout of the department affects supervisors' ability to collect objective information about workers and thus offer effective feedback to subordinates. When the layout of the department makes it difficult for managers to see and monitor employee behavior (e.g., department members are spread out over several rooms and are concealed behind heavy machinery), less information is obtained by the manager upon which he/she can base feedback.[1] Furthermore, because all department members work in the same layout, they experience the same level of visibility. These factories have a common functional structure in which each department shares the same work process, so that all tasks in each department are very similar. Therefore, similarities in layout of each department can be expected and visibility can be conceptualized as a group level variable that influences all members of each department.

In the present study, the visibility of the department did not change over time. The only manipulation employed was giving feedback to the supervisors. We hypothesized that because different levels of visibility have different effects on the ease of leader-member interaction, low visibility will moderate the effectiveness of the intervention. The moderation effect of visibility is based on the assumption that successful SBS intervention is a function not only of external feedback provided by the research team (or an immediate superior) but also of an internal feedback cycle. Increased emphasis on safety during informal exchanges increases the likelihood of workers' safety behavior being reinforced by supervisory recognition, and unsafe behavior punished (Barron and Erev, 2003; Erev 1998). This, in turn, reinforces managerial safety practices.[2] With low visibility, reinforcement cycles will occur infrequently, with less immediacy, inevitably becoming less effective (Skinner, 1974). Managers in low-visibility departments witness fewer incidents of safe/unsafe behavior, and hence are unable to provide immediate feedback, so that their workers are likely to behave less safely (see Zohar & Erev, 2007). Low visibility will thus reduce supervisory commitment which, in turn, will result in less effective intervention. Therefore, we define internal feedback as a cycle in which the manager's safety interactions with his/her subordinates are reinforced by their safe behavior, and the subordinates in turn are reinforced by his/her insistence that they behave in a safe manner.

Hypothesis 1. *Departmental visibility scores will be positively correlated to supervisory improvement in safety-related interactions. Supervisors in high-visibility departments will show greater safety-related interactions than those in low-visibility departments.*

[1] Previous research on feedback interventions show that their effectiveness is likely to depend on their ability to facilitate supportive information, social recognition, and objective rewards (Stajkovic & Luthans, 2003) without leading to overreaction (see Kluger & DeNisi, 1998). The current analysis focuses on the assumption that the effect of visibility on the implied rewards is not obvious.

[2] Notice that this is similar to the positive effect of visibility in social dilemmas (see Kerr, 1999).

Hypothesis 2. *Visibility scores will be positively correlated with employee's safe behavior. Employees in high-visibility departments will behave more safely than those in low-visibility departments.*

2. Method

2.1. Data collection

The study employs data collected during intervention studies conducted in five manufacturing companies. Two of these interventions were reported by Zohar and Luria (2003).

The five interventions included four main steps. Initially, there was an informal conversation with the senior manager in each company, during which managerial commitment to the intervention was established, and a member of the company's senior management team was assigned to coordinate the intervention. The second step involved designing details of the intervention jointly with the coordinator, followed by a presentation for senior management's approval. Baseline data were then collected, about two months prior to intervention, including rates of safety-oriented supervisory interactions, and workers' safety behavior.

The actual intervention was the fourth step, and lasted three to four months, during which bi-weekly personal feedback and coaching were given to shop-floor supervisors (level-1 managers) and their immediate superiors (level-2 managers). Feedback related largely to the number of safety-oriented exchanges out of the total reported work-related exchanges during consecutive weekly intervals. Each supervisor received individual feedback. Level-2 managers were given comparative information about all supervisors reporting to them, and were coached in how to inform each supervisor of their position relative to the other supervisors, and to communicate approval or disapproval. They were also instructed to inquire about reasons for success or failure, identify facilitators/inhibitors, and set specific improvement goals for the following two weeks. Senior (level-3) managers also received information during scheduled management meetings throughout the intervention, highlighting co-variation of supervisory practices and workers' safety behavior.

After the intervention we compared its effect on high- versus low-visibility departments. The present study deals with use of earplugs as the only universal behavior across the companies, although interventions covered a range of 7 – 9 department-specific behaviors.

2.2. Measures

Safety-related supervisory interactions were measured with one-page questionnaires about work activities and supervisory exchanges during the previous hours. Questionnaires were completed at random times during the workday, using experience-sampling methodology (ESM), which provides reliable data concerning daily activities that are little affected by memory bias (Alliger & Williams, 1993; Eckenrode & Bolger, 1995). The questionnaires, taken from Zohar and Luria

(2003), included: (a) a single-sentence description of work-related activities during the previous two hours; (b) a yes/no question about verbal/non-verbal interaction with the supervisor during that period; (c) if there had been, the subjects of interaction were marked on a short, empirically-derived checklist (i.e., productivity, quality, safety, other); and (d) if the interaction was verbal, the respondent was asked to provide a single-sentence quotation from it. The checklists and employee quotations were collated into three groups: safety-related, productivity or quality-related, and both. Supervisors received relevant feedback every other week, initially from members of the research team, and subsequently from their immediate superiors.

Workers' safety behavior (i.e., use of ear-plugs) was measured by trained observers who maintained a random observation schedule. Data collected during the first two weeks of the intervention were discarded, since this was the set-up period for both workers and observers. In order to unobtrusively observe workers' behavior, observers walked slowly through production halls and stopped to record data only after counting the number of workers with and without earplugs (or other unsafe behaviors such as walking only in permitted areas, using gloves and helmets, etc.). In all cases, workers seemed to ignore the observers' presence after the first two weeks. Improvement in safety behavior was assessed by subtracting the percentage of unsafe behavior during period *n* from the previous period (*n−1*).

Visibility was rated on a scale ranging from 1 (low visibility) to 5 (high visibility). The layout of the department largely determined the level of visibility, which is inversely related to the number of enclosed spaces or walls and the disposition of the working stations. Departments consisting of a single, open working space were rated 'high visibility' departments (5). Low visibility departments were characterized by many rooms, sometimes scattered throughout the plant, in which managers needed to actually approach each worker in order to observe or monitor her/his behavior (1). Medium visibility departments were characterized by 2–3 rooms that were not scattered as much throughout the plant (3).

Visibility was assessed by the member of the research team in charge of the intervention in the factory, who was very familiar with the structure and the layout of the factory and its

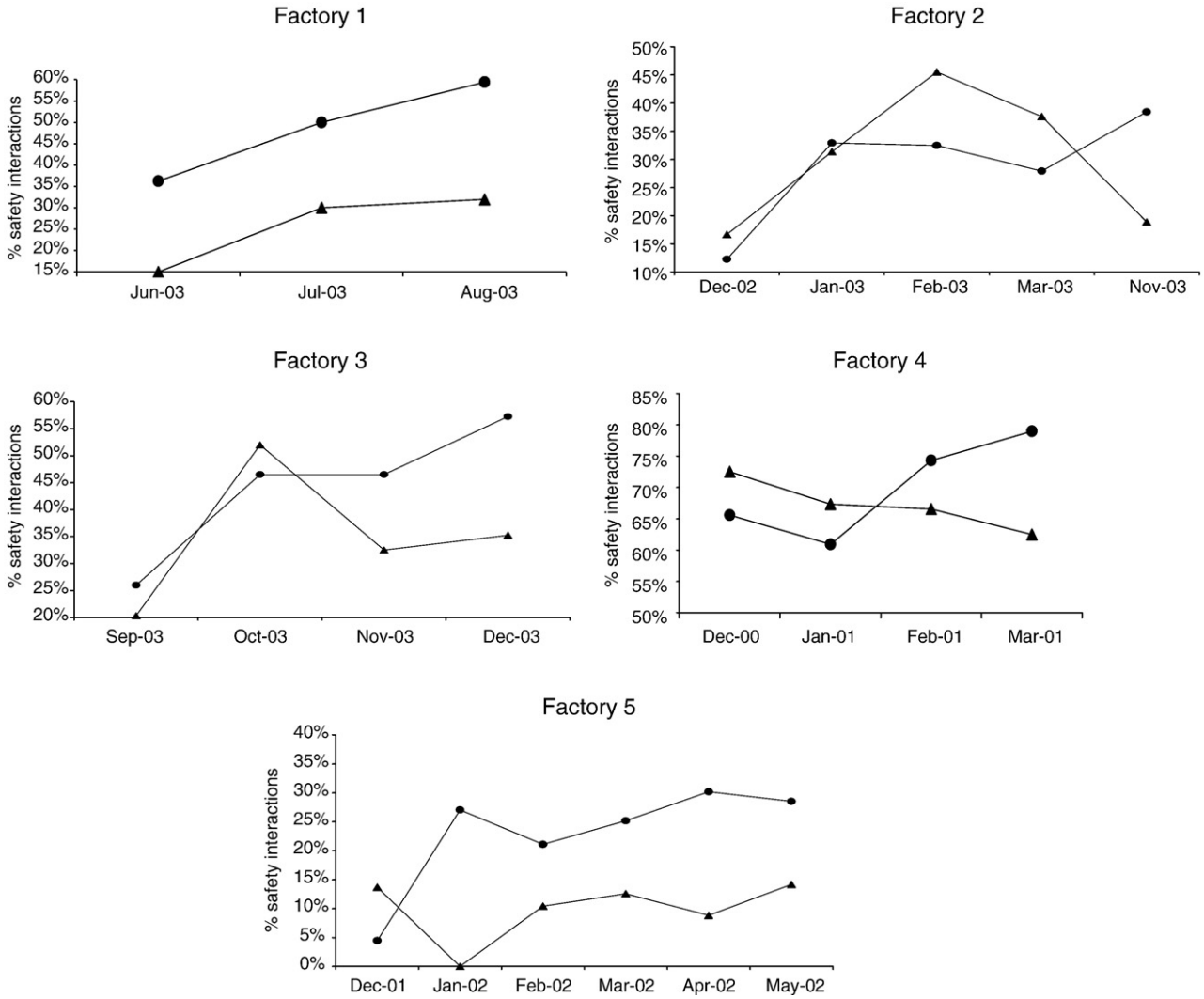

Fig. 2. Supervisory rate of safety related interactions in departments with low visibility ▲ and high visibility ●.

departments. Every member received a few guided tours with a representative of the plant and with each department manager in his/her area. Observations by the member of the research team lasted a few months in the factory. Each factory was assigned one research team member who conducted observations in that factory only. Therefore, it was not possible to test reliability between judges, or to use the same judge in all factories. However, in an effort to obtain an objective measurement of visibility, we employed a blind procedure in which members of the research team were not aware of study predictions and had no prior theoretical background on the concept of visibility. In addition, neither supervisors nor employees were aware that visibility was being measured.

3. Results

The study included 955 line workers and 57 shop floor supervisors in five plants. Most of the workforce was male (75%), average age 32 (SD=7), and average tenure 6 years (SD=6.2). The plants produce ice cream, chemical products, milk products, processed baked goods, and salads, respectively. Baseline supervisors' safety-related interactions with workers during the intervention averaged 30% of the total interactions, ultimately reaching an average of 46% – an increase of about 50% in safety related interactions by the end of the intervention. The outcome variable (employees' unsafe behavior) decreased, on average, by 16%.

We tested our hypotheses with hierarchical linear modeling (HLM), using SAS Proc Mixed (Littell, Milliken, Stroup, & Wolfinger, 1996), and taking into account the group level (departments) nested in the organizational level (plants).

Hypothesis 1 suggested that supervisors of high-visibility departments use more safety-related interactions than supervisors of low-visibility departments. Fig. 2 shows the ratio of safety-related exchanges over time as a function of visibility conditions in the five companies. These results confirm

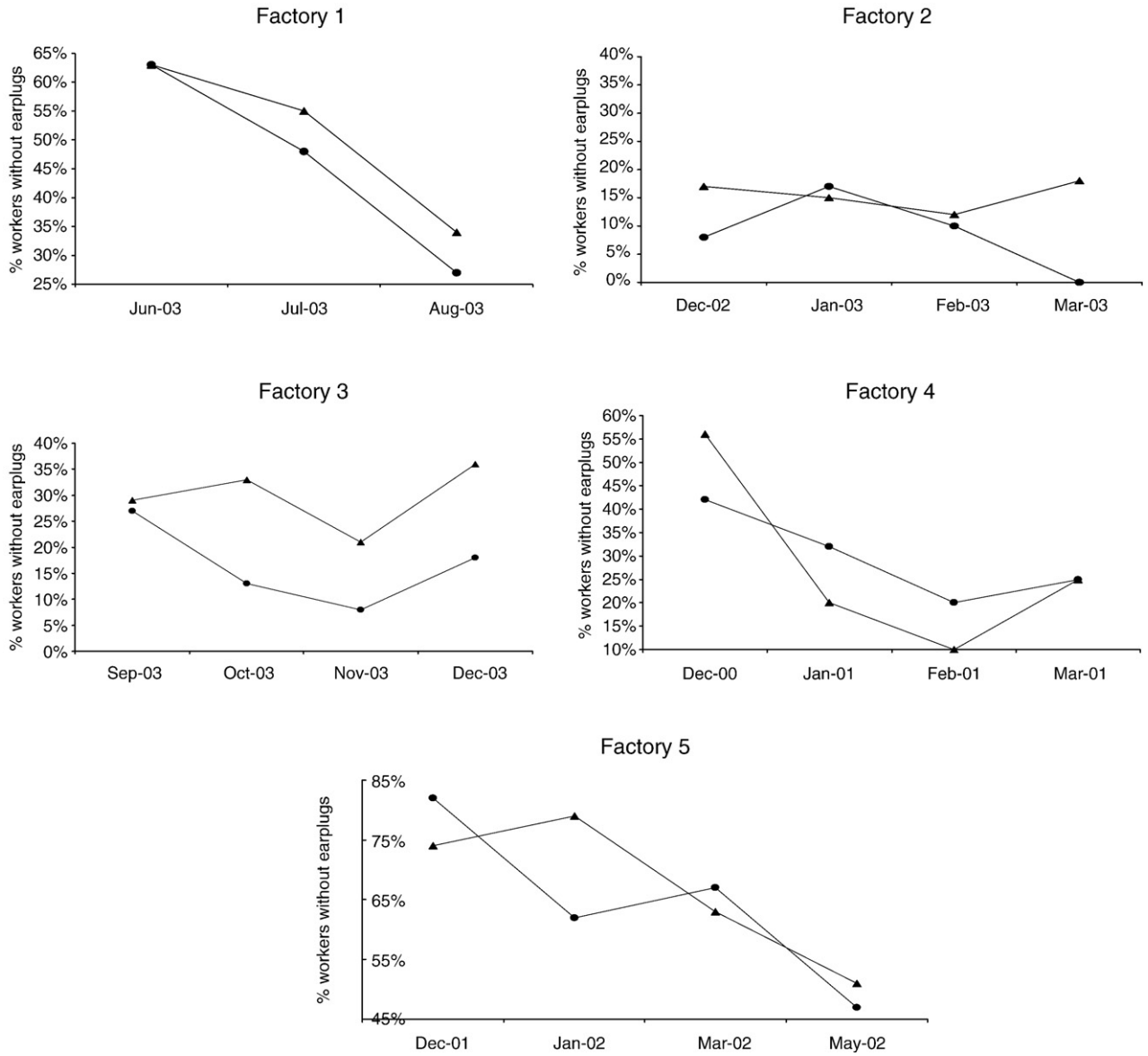

Fig. 3. Workers' rate of earplug violations in departments with low visibility ▲ and high visibility ●.

increased safety-related exchanges over time in the high-visibility departments (i.e., the ratio of safety interactions is larger in high-visibility conditions), and the difference between high and low visibility conditions increases over time. The difference is significant both when tested with a Sign Test ($p<0.05$), and by means of repeated measures (using the Mix Models procedure in the SAS), controlling for the effect of the factories in which the departments are nested. We found a significant visibility effect on safety interactions ($\beta=0.13$, $p<0.05$), and a significant time effect on safety interactions ($\beta=0.15$, $p<0.001$).

In order to test Hypothesis 2, we analyzed the relationship between visibility and workers' safety behavior, using the repeated measures Mix Models procedure in the SAS as described above. We found a significant positive effect of visibility on safety behavior ($\beta=0.1$, $p<0.05$), and of time on safety behavior ($\beta=0.11$, $p<0.001$), (i.e., workers behaved more safely under high-visibility conditions than under low-visibility conditions over time; one example of these safety behaviors is earplug violations, presented in Fig. 3). This confirms our hypothesis, and eliminates alternative explanations of the reported results. In particular, the lower rate of interaction in the low-visibility departments could have resulted from improved safety performance, which would have required fewer safety-related exchanges. Although supervisors had more reason to interact with workers in low-visibility departments, these departments did not promote higher interaction rates, supporting the reinforcement cycle hypothesis in that, despite safer behaviors and fewer violations in the high-visibility departments, supervisors engaged in more safety-related interactions with workers. One would expect that the reverse would be applicable, but Fig. 3 indicates that low-visibility departments were associated with more, rather than less, earplug violations, accompanied by a lower rate of supervisory interaction with workers.

4. Discussion

The main objective of this study was to test the effect of visibility on supervisory interventions. We hypothesized that visibility would generate an internal reinforcement cycle whereby more frequent managerial exchanges would result in improved safety behavior among workers, and encourage supervisory interaction. The results support the internal reinforcement cycle hypothesis. Supervisors in high-visibility departments increased their safety exchanges to a greater degree than those in low-visibility departments, and there was increased use of earplugs and safer employee behavior in these departments.

This resembles aspects of the Pygmalion effect whereby leaders invest more in the more capable members due to the immediate rewards for such investment (Eden, 1990). Similarly, leaders interact more often with favored, in-group members as opposed to out-group members, as outlined in the leader-member exchange (LMX) model and related research (Graen & Uhl-Bien, 1995).

The results identify an important moderator of supervisory-based safety interventions, suggesting that ongoing exchanges between leader and members exert a significant effect on leadership as leverage for improving safety. The effect of leaders' interactions is similar to the effect of their safety orientation on subordinates' safety climate and safe conduct (see Zohar & Luria, 2004). This suggests that leaders of distributed work groups, in which exchanges are severely limited, need further incentives for sustaining satisfactory levels of interaction. Identifying such incentives thus has much theoretical and applied significance. Furthermore, management can control employee visibility when designing new departments or improving existing ones, for example by changing the placement of machinery or moving the manager's office closer to the workplace. The results thus have practical applications for workplace organization and planning of organizational change.

The results are also relevant for safety management specifically and for managers' leadership development in general. Because manager-employee interaction regarding safety issues is a key predictor of employees' safety behavior in the workplace (Zohar, 2002; Zohar & Luria, 2003), managers' ability to inspect and detect employees' behaviors determines their reactions to these behaviors, and eventually enables them to improve safety behavior. Visibility is important because safety behavior plays an important role in safety outcomes, evident in the fact that failure to use protective gear provided at the workplace accounts for about 40% of work accidents. This statistic has not changed for more than 20 years despite continuing efforts (National Safety Council, 1999). Strategic safety management must therefore concentrate on reduction of unsafe behaviors, and be aware of the central role of the line managers as well as factors that influence their effectiveness in safety management. Better integration of safety in a workplace design that promotes visibility may improve safety outcomes by influencing organization members' safety behavior.

These results can be extrapolated to other organizational change processes because the leader-employee interaction impacts on a wide spectrum of behaviors, including safety behaviors. It is thus assumed that visibility has the potential to improve a wide variety of manager-employee interactions, apart from safety interaction. For example, leadership development programs offer a mechanism for obtaining information from subordinates that managers do not otherwise receive (Funderburg & Levy, 1997; London & Smither, 1995; Waldman, Atwater, & Antonioni, 1998). Feedback is usually obtained by means of surveys that ask subordinates to rate the frequency with which their manager exhibits different types of leadership behavior (Herold & Fields, 2004). In this study, the leaders' internal reinforcement cycle evidently influenced leadership behavior in addition to information collected from subordinates. Development programs must take into account that 'technical' issues such as ease of interaction and employee accessibility can influence a manager's motivation to modify his/her leadership behavior significantly. For example, it is possible that managers who are less accessible to their employees need stronger reinforcement in order to promote safety (or other facets) in their department. Another implication relates to layout of departments. According to the reinforcement cycle, it is possible that open space or layouts that allow higher visibility will promote better leadership and consequently improved performance. It is

important to note that such architectural design changes need to take into consideration other safety risks related to open areas (e.g., the transfer of airborne contaminants, noise control, ventilation performance).

Because this research was conducted as a field study, we could not control for all possible variables and thus be certain that visibility level alone was responsible for the effects. For example, it is possible that the level of visibility influenced communication between the employees themselves on safety issues, and not exclusively the interaction between the supervisor and the employees. In the present study, the only manipulation employed was increased supervisor interaction with employees; whether communication between employees changed as well was not recorded. Although the change introduced was modification of supervisor behavior and not direct manipulation of employee behavior, it is possible that the safety communication between group members changed in high visibility departments and contributed to the results. In light of our findings and the possible consequences for safety management and leadership development, we recommend further study of the effects of visibility on supervisors' safety-related interactions and employees' behaviors. We suggest that this effect should be tested in leadership development and other facet-specific programs such as quality and service.

We suggest that visibility should be tested in a more controlled environment, further testing its effect on behavior in the laboratory and in the field. The level of visibility can be studied with a better measure even in field studies. One suggestion is to measure visibility as rated by a few different sources, and not solely by one outside observer. For example, the manager of the department who needs to observe his/her employees is a good source for information about how much the employees are visible for him/her. A questionnaire can operationalize visibility in questions like 'I can observe my workers easily,' 'it takes me very little time to observe how all my workers are performing their tasks,' and so forth. Although measuring visibility with questionnaire provides a subjective measurement of visibility, we believe that together with the objective data it can better explain the effects of visibility evident in the data. Furthermore, in future studies one may try to control different work processes that exist in high/low visibility situations, thus obtaining a better measurement of visibility.

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