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Editorial

It is with my greatest pleasure to provide synopses of the truthfully remarkable articles in the 2015 fallissue of the *Journal of Safety Health and Environmental Research* (JSHER).

For "An Operant Analysis of Leadership Practices in Mining," Rost, Willmer and Haas interviewed safety leaders in the mining industry to understand their perspective on practices that create an overarching health and safety management system that facilitates miners' safety behaviors. The mine operations, located in California, Nevada, Missouri, Kentucky and Pennsylvania, included stone, sand and gravel, surface limestone, gold and underground limestone commodities. The authors coded the interview transcripts to identify management practices that support safe work behaviors using an operant model of effective supervision to guide the analysis. Using this model, the authors identified instances of safety-/health-related antecedents, performance monitoring and consequences that participating leaders found to be effective in supporting safe behavior of their workers.

Leaders most frequently described individual-level (e.g., one-on-one verbal reminders) and work-site-level (e.g., training) antecedent practices that set expectations for safety-/health-related behavior. Although important for communicating what is expected of workers, results also demonstrate that these antecedent strategies are not likely to sustain safe behavior unless combined consistently with relevant performance consequences (e.g., providing immediate verbal feedback, recognizing group performance in safety meetings). Thus, increasing the frequency of antecedent and consequence practices could lead to further gains in safety performance.

These data offer practical guidance concerning what specific leadership practices may support safe work behaviors. Organizations are encouraged to apply the analytical approach used by the authors to assess their leaders' communication practices to determine the extent to which these practices are likely functioning to support (or not support) workers' safety-/health-related behavior. Assessing leaders in this manner could inform what leadership and worksite practices should be improved to best support and sustain the safety and health behaviors of workers.

Next, Camino-López, Gonzalez-Gonzalez, Ritzel, Fontaneda-González and González-Alcántara compare the risk factors of incidents at the normal work site and at other work sites, incidents while travelling during working hours, and incidents while commuting between home and work. This study aimed to shed light on the possible differences between the risk factors of the incidents in each setting. By understanding the issues with traveling while working and to and from work, companies can start to develop programs that focus on these issues. All incidents involving sick leave from work of more than one day were selected for this study. The data were collected from the accident notification records held by the archives of the Spanish Ministry of Employment and Social Security. The number of incidents under analysis was 4,255,278. Sick leave from work as a consequence of the remission of injuries caused by accidents suffered in the past were excluded from the study.

The study was done with contingency tables, in which the chi squared statistic was calculated to test the null hypothesis or the independence of the variables under analysis with regard to the type of accident. This statistic showed the possible influence of the different variables on the type of accident that is suffered. The corrected standardized residuals (csr) were obtained, placing an asterisk after those with a value lower than 1.96 in absolute terms, which do not, therefore, reach the significance level of 95% that is sufficient to reject the hypothesis of the independence of the variables. According to the researchers, there is more than a random influence for those csr values that are over 1.96.

The study confirms that over the years incident rates have fallen in Spain, in all sectors, both for incidents in working hours and for commuting cases, and the probability of suffering a commuting incident is always much lower than the probability of suffering an incident during working hours. These findings may be taken into account by firms and can serve to improve prevention plans at the normal place of work and, above all, at other places of work, and while travelling between them.

In the third article, "Modeling the Dimensions of Ethical Leadership and Safety Climate in Aviation and Healthcare," Freiwald, O'Toole, Smith,and Thropp investigate the relationship among ethical leadership, an ethical workplace climate, safety climate, safety behaviors and measured safety outcomes of workers in the high-reliability organizations of aviation and healthcare. The authors' primary objective was to develop a model linking these factors and assess their fit within the model, specifically, how are safety climate and safety outcomes affected by both corporate-level workplace climate and site-level supervision and leadership.

Using the individual and combined populations of U.S. airline and inpatient hospital employees, the authors deployed a previously validated hybrid instrument and assessed the results using structural equation modeling. The results suggest that ethical leadership provides an opportunity for enhancing occupational safety through mitigation of occupational injuries, but has minimal affect on the broader elements of an organization's safety culture.

While somewhat cumbersome at first glance, the true value of this model lies in the ability to tease apart individual relationships for both investigation and implementation in the workplace. Examining couplets of path relationships can allow for improvement of the constituent factors involved. Most importantly, these paths might also be considered in the opposite direction of the model path. For example, the model showed a significant relationship between perceptions of ethical workplace climate and safety participation. In an applied context, a manager concerned with safety participation now has an additional antecedent to consider to improve its measures. The incorporation of ethical leadership items in workplace perception studies may provide early warning of employee perceptions that are strongly associated with negative safety outcomes and injury.

Finally, Gaymard, Tiplica, Koh and Wong pooled their skills in the fields of social psychology and engineering not only as academic researchers but also as safety and health practitioners with a view to improving pedestrian safety. The aim of the authors is to analyze the social representation of the pedestrian by comparing two different cultural contexts: Angers, a French city, and Singapore. If incidents are multifactorial, the role of the human factor is preponderant and understanding what happens on the level of interactions between road users is essential in order to implement safety measures.

The interest of studying social representations lies in the relation that they have with daily behavior. A specific tool in the field of study of social representations known as a characterization questionnaire was put on a platform online and filled out by students of the two countries concerned. The data were analysed by means of the Mann-Withney U test but also with a Fischer linear discriminant analysis and a quadratic discriminant analysis in order to assess the separability of the two student classes.

The findings confirm the hypotheses and show that the representation of the pedestrian reflects the cultural environment and cohabitation problems between road users. Thus, practitioners and policy makers must ask questions about the development of non-motorized modes of travel (i.e. pedestrians, cyclists) that are most certainly beneficial for health and the environment but which involve cohabitation problems. Psychological factors such as uncivil attitudes or lack of motivation to behave carefully accentuate exposure to risk. Social representations can, thus, constitute a useful indicator for decision makers and the implementation of measures to increase vulnerable users' safety. From a preventive point of view, the educational section is essential but to deal with cultural specificities, in certain cases, teaching about international mobility would provide against risks linked to changes in cultural environments.

I hope that you will enjoy these articles. As always, I look forward to hearing from you and welcome your submission of manuscripts to *JSHER*. Finally, *JSHER* welcomes new associate editors Dr. Todd Loushine and Dr. Sam Wang, and I look forward to working with them together for *JSHER*.

Yours sincerely,
Sang D. Choi, Ph.D., CSP
Managing Editor, *JSHER*

Acknowledgment of Reviewers

The *Journal of Safety Health and Environmental Research* gratefully acknowledges the following individuals for their time and effort as manuscript reviewers during the period between Sept. 1, 2014, and July 31, 2015. Their assistance in raising the standard of the manuscripts published is immense and greatly appreciated. Although the members of the Editorial Board (names are italicized) generally reviewed more manuscripts than others (and provided much additional support), most reviews were handled by ad hoc reviewers, chosen for their unique expertise on the topics under consideration.

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An Operant Analysis of Leadership Practices in Mining

Kristen A. Rost, Dana R. Willmer, and Emily J. Haas

Abstract

Organizational leaders play an important role in the facilitation of safe workplace behaviors. However, there is a lack of research that offers practical information for organizations concerning what specific leadership practices best support these behaviors. Safety leaders at organizations recognized for excellence in safety in the mining industry were interviewed to understand their perspective on practices that create an overarching health and safety management system (HSMS) that encourages the emergence of workers' safe behaviors. Leaders' descriptions of effective practices were evaluated through the operant model of effective supervision, which specifies that a leader's effectiveness is largely determined by the extent to which s/he manages the behavioral contingencies necessary for supporting desirable employee performance.

Researchers coded interview transcripts to identify instances of safety/health-related antecedents, monitoring, consequences, and emerging themes within each category. Results showed that the leadership behaviors and worksite practices most frequently used were antecedents, followed by monitoring and consequences, respectively. In identifying antecedents as the most common leadership behavior, this analysis also identifies the gaps and potential ways to improve leadership behaviors to focus more on monitoring and providing consequences to support safety/health behaviors of employees through the reinforcement of safe behaviors. These results also have implications for organization's implementation of HSMS through leadership practices.

Keywords
health and safety behavior, leadership, operant psychology, qualitative research

Introduction

Health and safety management systems (HSMS) are an "integrated set of organizational elements involved in the continuous cycle of planning, implementation, evaluation, and continual improvement directed toward the abatement of occupational hazards in the workplace" (Robson, et al., 2005, p. 5). HSMS differ from, and arguably improve upon, traditional health and safety programs by aligning the purpose and integrating all of an organization's health and safety management activities, providing overarching structure and organization, and being proactive rather than reactive (Haight, Yorio, Rost & Willmer, 2014; Robson, et al., 2005). The success of an HSMS often relies on and includes involvement from organizational leadership by outlining effective characteristics leaders should possess to best support the safety and health of employees on the job. Work-site leaders (e.g., senior managers, frontline supervisors) must play an integral role to ensure the company's commitment and effective workforce involvement.

For example, within its health and safety management system, the National Mining Association (NMA, 2012) provides guidance in leadership development via recommendations that leaders should hold themselves and respective employees accountable, be action-oriented and collaborative, communicate effectively, have integrity, provide effective performance feedback, be systems-focused, and have a personal vision and passion for safety excellence. Although these recommendations inform organizations about the characteristics of effective leaders, they do not offer ways these characteristics translate into specific leadership practices. For example, *how* do leaders provide effective performance feedback? Or, *what* common work-site practices are used by leadership to communicate with employees about safety and health issues? Organizations would likely benefit from research that offers ways to operationalize effective leadership practices among work-site leaders. These operational characteristics can be used to enhance ways the HSMS is implemented on site. In the present study, a theoretical framework was employed to identify these types of leadership characteristics within aspects of an HSMS.

Operant Model of Effective Supervision

According to an operant model of effective supervision (Komaki, 1998), supervisory practices that are most effective in supporting desired employee behavior align with the principles of operant psychology (e.g., reinforcement and punishment) (Skinner, 1974). These principles indicate that behavior is primarily a

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function of its consequences—events that follow behavior and increase or decrease the likelihood that it will occur again in the future. Antecedents—events that precede behavior—influence it as well, but to a lesser extent than consequences. Thus, supervisory practices that provide consequences for employee behavior, such as praise and corrective feedback, are central to supervisory effectiveness. Gathering performance information (or monitoring) is also important because this allows supervisors to provide feedback to employees based on actual performance (i.e., contingent consequences). Finally, antecedents—such as goal setting or training—influence behavior as well, but are most effective in combination with contingent consequences (Komaki, et al., 1982).

Thus, the operant model of effective supervision, posits that effective leaders continually engage in certain supervisory, communicative behaviors (Zohar, 2002). For example, in a series of research studies, effective leaders spent more time monitoring performance directly and providing a variety of consequences to their employees. However, the use of performance antecedents was not found to be consistently associated with effective leadership. [See Komaki (1998) for a summary of these studies]. This approach to studying leadership offers practical implications because it reveals the extent to which an individual leader is engaging in optimal behavior to support the desired performance of his/her employees (i.e., frequently monitoring and providing consequences and using relatively fewer antecedents). Therefore, the operant model provides a useful framework for classifying leaders' behaviors into functional categories that are known to effectively influence employee performance.

Although formative and subsequent studies (e.g., Komaki, 1986; Komaki, et al., 2011) have studied leadership at the individual level, the present study extends the application of the operant model to examine individuals' leadership behavior and broader workplace practices. Interview data with leaders from several mine organizations who were recognized for safety excellence were used in the current study. These leaders provided detailed information about both their organizations' HSMS practices and their own behaviors that likely support the safety and health of employees at these organizations.

The aim of this research is to offer guidance for organizations by 1) operationalizing leadership in terms of specific behaviors and common HSMS practices as used within mining organizations that demonstrate excellence in safety; and 2) classifying those behaviors and practices according to the operant model to reveal how they likely influence mine workers' safety performance.

Study Methods

Recruitment of Participants

Recruitment was based on an interest in analyzing the practices of companies that showed a system, or process of sustained safety performance management. Researchers used the Sentinels of Safety Award to identify companies that exhibit such a system or process for managing safety. This award is the oldest established award for occupational Safety (MSHA, 2011-12). The first winner was announced by President Herbert Hoover, a mining engineer, in 1925 while he was the secretary of commerce (MSHA, 2011-12).

The award program is now evaluated exclusively by NMA. The award's "recognize[s] achievement of outstanding safety performance, to stimulate greater interest in safety and to encourage development of more effective accident prevention programs among the nation's mineral (coal, metal and non-metal, stone, sand and gravel) mining operations" (NMA, 2014). To be eligible, a mining operation must: 1) report employment data to MSHA for each quarter in which it was active during the calendar year; 2) experience no work injuries in the subunits below that resulted in a fatality, permanent disability, days away from work or days of restricted work activity; 3) have a no days lost (NDL) injury incidence rate (degree 6) no greater than the national average for these same subunits; and 4) accumulate at least 4,000 employee hours in these same subunits during the calendar year (NMA, 2014).

Researchers used this criterion for participation to garner additional validity and reliability of leaders' responses. As a multi-year recipient, the researchers inferred that these organizations had some sort of established process or system for managing safety performance and the associated leadership practices and behaviors could be informative models for other mine organizations. Twenty-four mining companies received this award as least three times during 2005-10. Convenience sampling was used to recruit participants from this sample of 24 mines via phone and e-mail communication (Morse, 2010). Six interviews were completed with mining companies at which point the researchers started to hear recurring themes among leaders, indicating saturation of content (Corbin & Strauss, 2008).

Sample

The sample included individuals from six mine organizations who held various leadership positions such as plant manager, health and safety superintendent, and operations manager. Four mines were part of larger mining organizations and two mines were independent operations. The employee populations ranged from approximately 40 to 175. The mine operations were located in California, Nevada, Missouri, Kentucky and Pennsylvania, and included the commodities sand and gravel, surface limestone, gold, and underground limestone. Researchers traveled to five of the six mine sites to conduct the in-depth interviews. The other interview was conducted over the phone. Interviews ranged from 1 to 3 hours depending on the leadership role(s) of the participant. However, each leader interviewed was responsible for developing, implementing, and maintaining their organization's approach to managing health and safety on site.

Data Collection Instrument

A moderately structured interview protocol was developed and used to probe leading indicators of effective HSMS (Bennet & Foster, 2005). These leading indicators and an example interview question to probe each indicator follow:

Occupational health management: "What happens if someone gets hurt during the shift?"

Senior management commitment: "What are some of the short-term and medium-term measures and targets used to check whether the company is meeting its safety goal?"

Continuous improvement: "Describe a health and safety problem that was identified and dealt with in a way that people think is successful."

Risk management: "How is an incident evaluated by the organization? Can you give me an example to describe the evaluation?"

Communication: "What activities or practices does the company use to communicate health and safety messages?"

Competence: "How does the company make sure that the employees know how to do handle emergencies?"

Employee involvement: "What are other ways you think employees could get involved in improving company health and safety?"

The interview protocol was designed so participating leaders from each mine could discuss their organizational behaviors and practices associated with the aforementioned indicators of interest. The interview protocol was approved by the National Institute for Occupational Safety and Health (NIOSH) Institutional Review Board (IRB).

Data Analysis

All six interviews were audio recorded and transcribed for data analysis and coding. The coding analysis sought to operationalize leadership behaviors and work-site practices involved in HSMS implementation and classify them according to the functional behavioral categories in the operant model of effective supervision (Komaki, 1998). Researchers first read through the transcripts and identified examples of the three major behaviors (i.e., antecedents, monitoring, consequences) in the operant model. Both initial and focused coding occurred that remained attentive to the three categories within the model; therefore, a theoretical coding framework was utilized to answer the research aim (Boyatzis, 1998).

Two researchers jointly coded one interview transcript to identify the three behavioral categories and emerging themes within those categories. Researchers separately coded 20 to 30 pages of the transcript at a time, then reviewed their codes line-by-line to discuss agreements and disagreements in the identification of the three categories. A preliminary codebook was established based on the coding and review of the first interview.

Once agreement of the preliminary codebook was established, the researchers were randomly assigned as primary coder on two or three of the remaining five interview transcripts. Inter-rater reliability checks were completed to ensure that the data interpretation was credible and consistent between the researchers (Lincoln & Guba, 1985). The inter-rater coding meetings applied the steps as outlined by Boyatzis (1998) for establishing a reliable code in qualitative data. These steps involved: 1) One researcher reviewing a transcript and applying the pre-established code to the data; 2) the second researcher independently doing the same (i.e., using the code to assign categories and associated patterns emerging in the data); and 3) computing the inter-rater reliability by indicating agreement or disagreement.

All of the categories and patterns that emerged during this analysis were organized into a codebook in order to accurately display and organize the data. Researchers validated the codes and final codebook by coding the entire raw data set using the reliable code consistently throughout the qualitative analysis (Boyatzis, 1998). Table 1 (pp. xx, xx) displays the final codebook with themes, codes and definitions for the major categories in the operant model. Consistent themes emerged within each category across participants, indicating saturation of content during data analysis.

Results

Leaders described behaviors and practices that supported each of the three categories (i.e., antecedents, monitoring, consequences) in the model. As shown in Table 2 (p. xx), the analysis revealed that antecedents were used most often (54.91% of all coded leadership behaviors and work-site practices), followed by monitoring (26.56%) and consequences (18.75%), respectively. Data from all six organizations were similarly distributed across the categories in the operant model (Table 2). The next section discusses consistent themes that emerged in the data to provide specific examples of leadership behaviors and work-site practices within each category in the operant model.

Antecedents

Antecedents were frequently used to communicate safety/health-specific performance expectations to employees. The most common antecedent code was *(re)Learning tools of the trade* (Table 1). This communication practice most often included the use of established protocols like training and routine safety procedures.

For example, one leader explained the importance of providing training for new miners: "The minute you cross that track we give you site-specific training so that you're aware of all the conditions at the mine" (Organization #3). Relatedly, another leader described training for new haul-truck drivers when he said, "[S]ay we bring in a haul-truck driver . . . [he goes] through the safety and health hazards of the job in-depth, review risk assessments that have been done on it. [He's] shown the equipment" (Organization #4).

Leaders also provided examples of routine safety protocols of which employees were expected to engage. For example, one leader described the protocol for conducting job safety audits (JSAs): "We do JSAs here also—not on the common jobs, but if there's something unusual, something we might do every 6 months, every 18 months or something that's for whatever reason more challenging than the day-to-day work, we'll stop and do a JSA before we start and just talk through what PPE [personal protective equipment] we need, what things we need to watch for, etc. (Organization #5).

Other examples of routine safety protocols included prejob meetings, mine site policies that require all miners to wear safety glasses, and new miners to wear orange hard hats as a signal for more experienced miners to pay special attention to the novice workers' activities.

Leaders also communicated expectations to employees in formal meetings (see the code *Organizational meetings* in Table 1). For example, one leader described how safety topics were an important discussion point in all meetings: "[E]very meeting starts with a safety share . . . you open up, 'Okay does anybody have a safety share?'" (Organization #4). Other leaders described using meetings to remind the crew about safety goals and priorities. For example, one leader said, "[Y]ou have safety meetings and you remind the group, 'Hey it's zero; we're striving for zero'" (Organization #1).

Table 1. Themes, Codes & Definitions for the Major Coding Categories

Theme	Code	Definition
Antecedents		
Leaders communicate performance expectations to employees		
Multiple communication mediums used to inform and promote safe behavior	Getting it in print	Leaders use printed materials to document safety expectations to employees
	On the record	Employees are expected to produce written safety reports
	Learning from mistakes	Leaders present information about past incidents in an attempt to avoid similar incidents in the future
	Organizational meetings	Structured format to dialogue with employees about safety expectations and quality improvement
Positive role models	Leaders exhibit desired behaviors	Leaders demonstrate behavioral expectations to employees by engaging in job tasks expected of employees
	Peer-to-peer influence	Leaders encourage employees to communicate safety expectations to one another
Established protocols/ Continuous quality improvement	(re)Learning the tools of the trade	Protocols are in place to help employees learn how to use equipment, tools, or procedures required for their jobs
	Improving the tools of the trade	Leaders pay attention to the negative outcomes internally/externally and take action to prevent incidents at workplace
	Anyone can do it	Leaders promote and provide cross-job training to ensure full operation when people are absent
	Just a reminder	Leaders provide a reminder or convey a rule about safety expectations (informally and not as part of a meeting or training)
Here's your chance	Lateral opportunities	Leaders provide lateral, cross-job training opportunities to help employees build skill sets
	Are you promotion material?	Leaders provide new opportunities with the purpose of filling the pipeline of future leaders
	Say something, do something	Leaders encourage employees to communicate and be proactive to prevent incidents

Theme	Code	Definition
Monitoring		
Leaders gather information about performance		
Gotta see it to believe (or fix) it	Show me what you're doing	Leaders directly observe employees on-the-job or inspect completed work
	Let me help	Leaders work alongside employees to see what changes may necessary and to improve morale
	Yes, you ARE promotion material	Leaders observe employees to determine if they are fit for potential advancement opportunities
Give me the scoop	What have you been up to?	Leaders ask employees questions about work one-on-one or group settings
	Hmm, what have THEY been up to?	Leaders ask individuals, often in a leadership position, about work of other employees
	Off-the-clock topics	Leaders utilize lunch, coffee, and other social breaks to dialo with employees about work
We've got history	Going back in time	Leaders consult archival records to monitor trends in performance
	Using the past to change the present	Leaders use archival records/history to make positive change organization
Consequences		
Leaders communicate knowledge of performance		
I know what you did	One-on-one	Leaders communicate (e.g., face-to-face, written note, e-mai privately with an employee about his/her work
	Public acknowledgement	Leaders communicate publically with employees about their work
	Getting it in print	Leaders use printed materials to recognize performance or address concerns
And here's what I'm going to do about it	Atta boy!	Leaders recognize employee(s) accomplishments publically privately
	Nip it in the bud	Leaders communicate disapproval about employee performa
	Continue to monitor established protocols	Leaders acknowledge performance in a neutral manner witho expressing approval or disapproval

Table 2. Distribution of Antecedents, Monitoring & Consequences per Organization

Organization #	Total Coded Leadership Practices	Antecedents % (*n*)	Monitoring % (*n*)	Consequences % (*n*)
1	115	45.22 (52)	28.70 (33)	26.09 (30)
2	61	54.74 (34)	24.59 (15)	19.67 (12)
3	80	56.25 (45)	26.25 (21)	17.50 (14)
4	52	54.77 (29)	26.92 (14)	19.23 (10)
5	57	52.63 (30)	36.84 (21)	10.53 (6)
6	83	67.47 (56)	18.07 (15)	14.46 (12)
Total	448	54.91 (246)	26.56 (119)	18.75 (84)

Note. For each organization, percentages were calculated by dividing the number of coded instances for a given category (antecedents, monitoring or consequences) by the total number of coded instances for all categories.

Another leader explained how meetings are used to ensure everyone understands work priorities: "[T]he crew gets together instead of just showing up to work and assuming that you know what's going on and what the priorities are for the day . . . talk about any issues from the shift prior, from the crew prior to them, whatever the case is regarding safety or the efficiency of the mine . . . everybody's on the same page" (Organization #4).

Generally, leaders felt that meetings were an efficient platform to regularly communicate expectations to employees. As one leader put it, "You can accomplish quite a bit during a meeting that one day a week" (Organization #1).

Work-site practices, like the trainings, routine protocols and meetings, were the types of antecedents most frequently described during the interviews. Leaders also discussed individual, tailored behaviors they utilized to communicate expectations. Examples include modeling safe behavior, providing informal safety reminders in regular conversations, and encouraging employees to communicate safety expectations to one another and to communicate and be proactive to prevent incidents.

Overall, performance antecedents were the most frequently coded category in the operant model. Participating organizations used a variety of work-site practices and leadership behaviors to set expectations for safe employee performance.

Monitoring

The second most frequently used category in the model was performance monitoring. Directly observing employees during work tasks or inspecting their completed work are the most effective types of performance monitoring (Komaki, 1998). Monitoring codes that emerged in the current data were mostly behaviors that leaders routinely engaged in to gather information about the safety behavior of individual employees, group safety performance and employees' understanding of safety protocols. For example, as depicted in the following quotation, leaders commonly gathered information about a specific safety behavior by directly observing employees while they engaged in job tasks: "[Y]ou know where the emergency steering is?' Show me. Show me how to use it. Show me what to do . . . we don't just say, 'Do you know where it's at?' We want you to demonstrate it and show it" (Organization #6).

Describing the use of a similar monitoring practice, a different leader explained, "If I drive through the yard I'm watching. If I'm coming up on a guy [truck driver] I'm listening for his back-up alarm, I'm watching to see if he's going to turn his head" (Organization #1). In another organization, leaders at all levels were expected to get out in the field and have frequent direct contact with employees on the job: "[F]rom front-line supervision all the way up to general managers and regional and corporate, and they have directives and expectations to get out and about and just not be that desk leader sitting at a desk" (Organization #4).

Leaders also gathered information by asking employees questions about their work and gathering input on safety issues (see the code *What have you been up to?* in Table 1). For example, one leader explained, "[J]ust as far as walking around with the employees and saying, 'Hey come here for a second . . . asking questions and getting their input: 'Well, what do you think?'" (Organization #1). Another leader described the importance of asking employees questions one-on-one: "I don't think a day goes by that I don't individually go somewhere and talk to somebody . . . if you get them individually they'll say things to you and you can relate to them and talk to them" (Organization #6).

Several leaders described the inclusion of employees in root-cause investigations after a safety incident to prevent similar events in the future. For example, one leader said, "We'll get with the group of people that were directly involved . . . get their input" (Organization #4). A different leader explained a similar practice:" We've done them [incident investigations] enough people aren't scared of them. They know it's not a witch hunt. We'll go down and we'll keep asking them why—why do you do this? Why'd this happen? We'll keep drilling down until we find out what the root cause of the incident was" (Organization #5).

As shown in Table 1, other consistent themes related to monitoring that were revealed in the analysis included leaders working alongside workers to understand possible issues, observing workers during job tasks to determine potential for advancement opportunities, asking other leaders about employee performance, utilizing informal gatherings (e.g., lunch and coffee breaks) to dialogue with employees about work, and consulting archival records to monitor trends in safety performance.

Consequences

In comparison to the frequency of antecedents and monitoring revealed in the analysis, relatively few portions of the data were coded as consequences. Leaders engaged in a variety of behaviors (e.g., providing immediate verbal feedback, recognizing group performance in safety meetings) and described common organizational practices (e.g., congratulatory celebrations) that likely function as consequences to reinforce the safe behavior of their employees. Leaders also emphasized the importance of understanding employees' preferences for public recognition and the importance of providing consistent consequences (positive or negative) for specific employee safety-related behaviors (e.g., reporting near-hits). For instance, when communicating knowledge of employee performance, leaders used an equal amount of positive (see the *Atta boy!* code in Table 1) and negative (see the *Nip it in the bud* code in Table 1) consequences. As one leader expressed, "[W]hether good or bad, I will talk to the people that I'm walking with and I will express my opinion" (Organization #1).

Several leaders described the importance of providing positive feedback to individual employees. However, leaders also discussed the importance of considering employees' preferences related to this positive recognition, revealing that some employees might appreciate being recognized in a way that draws attention and others may not. One leader said, "[E]every employee I've ever come across enjoys some kind of positive recognition, especially in front of their peers" (Organization #3). Another leader explained a way to emphasize employee contributions in a more indirect manner: "[I]f somebody turns something in on a near-miss we want to take and teach that and recognize, not necessarily the individual if they don't want that, but recognize the hazard that was prevented because they brought it up" (Organization #3).

For group-level performance, leaders often delivered positive consequences back to the group as a whole (see the *Public acknowledgement* code in Table 1). For example, the following excerpt illustrates a leader providing a positive consequence to a group of employees in a safety meeting: "I also go to safety meetings and say, 'Guys I was just here a week ago, walked the plant, place is spotless. I really appreciate the work you're doing'" (Organization #1). In addition, a majority of the leaders used celebrations such as barbeques or holiday parties to recognize accomplishments related to group safety performance.

When communicating disapproval about employee performance, leaders emphasized the importance of providing immediate corrective feedback to employees after an unsafe act was directly observed. To illustrate, one leader described a situation in which an employee was not wearing the proper PPE: "We'll follow-up on safety glasses. If we see somebody forget and they might say, 'Oh I just had them on, just took them off because they were fogged up.' I remind people" (Organization #6). The same leader explained that following up immediately was a general organizational practice: "If you see somebody doing something they shouldn't be doing go talk to them right now . . . then we'll discuss it among all employees involved." Other leaders also supported this practice and stated the importance of holding everyone accountable for safety and providing corrective feedback "right then and there" if an unsafe act is observed.

Finally, all participants emphasized the importance of encouraging employees to report near-hits or speak up about safety issues to establish open communication between employees and leadership. In addition to encouraging these behaviors, leaders discussed the importance of providing consistent positive consequences and *not* reprimanding employees for speaking up about safety issues and reporting near-misses. One leader explained that the organization had established trust with employees by providing consistent consequences: "[E]specially our more seasoned employees, they all know they're not going to get in trouble, we need to know things. . . there's not going to be any reprisal [for reporting near-misses], there's not going to be anything other than, 'Let's talk about it . . . let's fix it, let's get better'" (Organization #4).

Another leader explained the general organizational practice of "pushing the stop button" when unsafe conditions are detected by saying, "That's our rule, that's what we live by, and that's what they understand. 'That's not safe, I'm not going to run it' . . . and they know there's no reprimand" (Organization #3).

Discussion

The results indicate that organizational leaders used a mix of antecedents, monitoring, and consequences intended to support the safety and health of their employees. Furthermore, the analysis revealed the role of mine site leadership in promoting the HSMS of their respective organization. This role consisted of leadership practices such as providing individual-level (e.g., one-on-one verbal reminders) and work-site-level (e.g., training) antecedents that set expectations for employee safety/health-related behavior. Although important for communicating what is expected of employees, antecedent strategies such as reminders and safety training are not likely to maintain and sustain safe behavior unless combined consistently with relevant performance consequences (Komaki, 1998; Komaki, et al., 1982). Thus, increasing the frequency of monitoring and consequence practices seems feasible and could potentially lead to further gains in safety performance.

Organizations both within and outside of the mining industry could glean information from Komaki's (1998) operant model to assess the leadership behaviors and work-site practices involved in their HSMS in order to determine where they might best focus their efforts and allocate resources. For example, if an organization finds that it is lacking in performance monitoring, it could implement a leadership development effort that emphasizes the monitoring behaviors of leaders (see *Monitoring* codes in Table 1), which may result in increased communication between leaders and employees, setting the occasion to use a variety of consequences (see *Consequences* codes in Table 1) to support safety and health behaviors. Readers may refer to Kines, et al. (2010) and Zohar and Luria (2003) for examples of leadership-based interventions of this type.

The present analysis may be informative for organizations implementing an HSMS, then trying to determine applicable leadership practices onsite. The approach undertaken in this study could be used as an assessment method to identify effective leadership practices. However, the leadership behaviors and work-site practices revealed in this analysis were categorized based on how these behaviors would likely influence the behavior of employees based on the principles of the operant model. How these leadership behaviors and practices actually affect employee behavior in a given organization is an empirical question and should be addressed in future research.

For example, it is possible for site leaders to use these specific types of feedback to encourage a specific behavior, such as information about, methods to, and consequences for trying or not trying to reduce exposure to dust. Because several technologies can measure real-time dust exposure, it is possible that leaders can more easily measure, via dust exposures, what types of feedback, whether informative, observing, or consequential, is most helpful in influencing workers' safety performance. This is just one example of how organizations can utilize the operant model to tailor feedback.

Conclusion

The present study aimed to operationalize the leadership practices of several mining organizations recognized for safety excellence in the industry. Specific leadership behaviors and common work-site practices were identified and evaluated according to the operant model of effective supervision, and the analysis revealed that antecedents were used most often, followed by monitoring and consequences, respectively.

These results may be informative for organizations striving to improve communication between employees and site leaders or those evaluating current HSMS practices for continuous improvement. Organizations could apply the process used here to assess the current state of their leaders' communication practices to determine the extent to which these practices are likely functioning to support (or not support) employees' safety- and health-related behavior. Assessing leaders in this manner would inform what leadership behaviors and work-site practices could be improved to provide the monitoring and contingent consequences that are likely necessary to best support and sustain the safety and health behaviors of employees.

In conclusion, the present study provides a detailed account of leadership in organizations recognized for safety excellence in the mining industry, and classifies leadership behaviors and practices according to an operant model to reveal how they likely function to influence safety performance. Future research is needed to demonstrate a functional relationship between the leadership behaviors and practices revealed in this study and safe behavior of employees in mining organizations. ✪

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Accidents in Working Hours & Accidents While Commuting: Spain, 2006-2010

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Abstract

Differences in workplace accidents during working and commuting hours from 2006-2010 in Spain are analysed by gender, size of firm, occupation, and type of injury. The study confirms that, over the years, accident rates have fallen in Spain, in all sectors, both for accidents in working hours and for commuting accidents, and the probability of suffering a commuting accident is always much lower than the probability of suffering an accident in working hours. The high percentage of accidents among younger drivers stands out among the road traffic accidents. These findings may be taken into account by firms and can serve to improve accident prevention plans at the normal place of work and, above all, at other places of work, and while travelling between them.

Keywords
accidents, working day, commuting, accident cost

Introduction

Every 5 seconds, a worker in the European Union is involved in an accident at work. Every 2 hours a worker dies for this same reason (Takala, 2006). These workplace accidents can occur during working hours, while commuting from home to work and on the way home. Moreover, among the accidents in working hours, a distinction is drawn between accidents suffered at the normal place of work, those at different places of work, and those that occur while traveling during working hours. It is important to note that accidents while traveling between workplaces include those suffered by professional drivers such as taxis and HGV drivers. There has been a notable fall in road-traffic deaths (open road and built-up area) in Spain in recent years. The mortality figures of about 170 deaths per million inhabitants recorded in the early nineties of last century fell to the figure of 67.2 recorded in 2008 for Spain. In 2008, there were 3,100 road deaths in Spain, 2466 corresponding to accidents on the open road and the rest to accidents in built-up areas; 79.4% of these victims were male (Martinez-Garcia, 2009).

Moreover, road traffic accidents have a decisive influence on accidents at work. In fact, the seriousness of accidents is affected to a great extent by the deaths that occur as a consequence of road traffic accidents during working hours and when commuting to and from work. In the U.S., 25% of deaths related to activities in the workplace are due to road traffic accidents (Toscano & Windau, 1994), 30% in Canada (Rossignol & Pineaul, 1988), 60% in France (Charbotel, et al., 2001), 49% in Australia (Driscoll, et al. 2003) and 50% in Finland (Salminen, 2000). In Spain, around 90,000 people a year suffer a traffic accident related to work of which 15,700 are in the Catalan region, a global figure that still causes about 400 yearly deaths. In 2008 in Spain,

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there were more than 1,065 fatal work accidents, of which about a third had to do with traffic (European Transport Safety Council, 2009). The importance of this may be seen in that 39% of deaths that happen while at work are related to road traffic accidents (Harrison, 1993), although only 4% of deaths that occurred on the road are linked to activities at work. With the aim of improving this situation, the European Commission (2013) has proposed the objective of reducing by 50% the number of work-related deaths on the road by 2020.

Greater in-depth knowledge of accidents is needed to achieve that objective; a great many authors maintain that an acceptable health and safety policy depends gaining knowledge on what causes accidents (Williamson & Feyer, 1998). These causes should be analysed in the light of different concepts such as environmental, organizational, and behavioral factors (Boufous, 2006). Other authors have affirmed that it is necessary to look in greater depth at the causes of accidents, in order to improve preventive actions and to promote them on the basis of scientific evidence (Courtney, et al., 1997; Hagberg, et al., 2007; Rivara, 2003).

It is true that there are various studies on road traffic accidents while traveling during working hours; however, the majority refer to the transport industry and to transport-related occupations (Salminen, 2000). It is logical that drivers, HGV drivers and long-distance PSV drivers will be the most likely to fall victim to these types of accidents, given that their exposure to risk is greater since their working day is on the road (Boufous, 2006).

The typical victims of fatal traffic accidents during working hours in Australia were found to be adult male lorry drivers (Harrison, et al., 1993) and professional drivers were found to have the greatest impact on injuries and the highest mortality rates due to workday accidents on the road (Bylund, et al., 1997). Other studies have indicated that older drivers had the greatest risk of suffering permanent disability or death during their work shift, as taxi drivers, as lorry drivers, and on trips to and from work (Boufous, et al., 2009).

Driving as part of the job constituted a very dangerous activity. However, professional drivers have shown high levels of risk behavior, which might be due to excessive levels of confidence and the false belief that they are safer, more skilled, and less likely to be involved in a road traffic accident than other road users (DeJoy, 1989; Goszczynska & Rosla, 1989; McCormick, Walkey & Green 1986; Svenson, 1981; Svenson, et al., 1985).

This excessive trust was also generated in groups of younger males, who tend to believe that the risks on the road do not affect them directly (Lichtenstein, et al., 1978), even though they perceive them, which is the real problem. Those risks are often taken solely for fun; interestingly, 31% of young men confessed to taking risks for that reason, as against 7% of women (DeJoy, 1991). In addition, various studies on driving have pointed out that men, and especially younger men, generally display higher risk behaviors and attitudes than women (Laapotti, et al., 2001; Parker, et al., 1995).

On the other hand, the percentage of accidents of women while commuting is greater than their percentage in the employed population and their percentage of participation in traffic, which means they are a high risk group. So, it may be mentioned that men make 3 of every 4 trips and suffer 5 of every 6 accidents, but are only injured on 50% of all occasions, while women suffer fewer accidents and are involved in a smaller number of trips, but are injured in 2 of every 3 commuting accidents (Salminen, 2000).

The cost in human life is high in road traffic accidents, but in addition to this, there are other associated economic costs that are substantial for both business leaders and society in general, even though they are on occasions overlooked (Boufous, et al., 2009). It is estimated that the costs arising from the injuries that occur due to road traffic accidents were 2 to 6 times greater than those due to injuries in the workplace (Salminen, 2000). In fact, the cost of traffic accidents related to labor activities is calculated to be 2.7 billion Pounds Sterling every year in Great Britain and $45.7 billion in the U.S. (Boufous, 2009).

A difference should be recognized in commuting accidents between accidents when traveling in a vehicle and accidents when on foot. More men than women drive at any age, so it is expected that they will be pedestrians less frequently and that they will chose more often to use the car instead of using public transport and commuting to work on foot. Thus, the most immediate explanation of the greater risk for women is that the people who drive less will, probably, walk more, for which reason, as pedestrians, they will expose themselves more to situations of risk (Holland, 2007). Moreover, the part of the journey made on foot can be the most dangerous part of the journey (Salminen, 2000).

Finally, with respect to accidents in the workplace, many articles have analyzed the risk factors of these sorts of accidents: accordingly, the influence of age has been studied (Salminen, 2004) and gender (Kelsh & Shal, 1996; Linquist, et al., 1999), as well as length of service (Alamgir, 2009; Lin, et al., 2008) and the activity that is performed (Goldcamp, et al., 2004; Kines, 2002). As noted, other authors have studied commuting accidents and the risk factors for workers dedicated to driving. Because of the lack of research that compare the risk factors of accidents at the normal work site and at other work sites, accidents while traveling during working hours, and while accidents commuting between home and work, this study seeks to shed light on the possible differences between the risk factors of the accidents in each of these settings. By understanding the issues with traveling while working and to and from work, companies can start to develop programs which focus on these issues.

Materials & Method

In Spain, accidents at work are defined as an injury suffered by the worker as a consequence of the work to be performed. While not considered as such in many countries, commuting accidents are considered workplace accidents in Spain.

Business directors are obliged to insure their workers and to notify the Ministry of Employment and Social Security of all accidents at work in which their workers are involved and whose injuries involve sick leave of one day or more. In addition, taking into account that the daily compensation that a worker receives is notably higher when it is due to an accident at work, we can consider that the notification of accidents at work in Spain is close to 100%.

For this study we wanted to view accidents that occurred in these situations:

•in working hours:

•at the normal building or place of work;

•at another building or place of work, other than the normal one;

•while traveling, within working hours;

•commuting accidents that occurred when traveling from home to the work place or from work to home.

Finally, in Spain it is the obligation of the doctor on duty to diagnose the seriousness of accidents in working hours. From among the accidents under analysis, 98.9% were qualified as minor accidents, 1.0% as serious and 0.1% as fatal accidents.

Data Collection

All accidents involving sick leave from work of more than 1 day were selected for our study. The data were collected from the accident notification records held by the archives of the Spanish Ministry of Employment and Social Security. The number of accidents under analysis was 4,255,278. Sick leave from work as a consequence of the remission of injuries caused by accidents suffered in the past were excluded from the study.

The accident rates were calculated per 1,000 workers, dividing the number of accidents by the annual number of workers that were exposed each year. The employment data, for the denominators of these tasks were also taken from the Ministry of Employment and Social Security. The same number of workers were considered, both in the work-time accidents and in the commuting accidents. In Spain, it is estimated that as a maximum, 1.5% of all workers carry out their work at home (ENCT, 2011). Faced with the impossibility of estimating this percentage for both men and women, it was decided to consider the same number of workers for the purposes of calculating these rates, both for work-time accidents and for accidents while traveling.

Serious and fatal accident rates were calculated per 100,000 workers for ease of understanding.

Study Design

For the time period 2006-2010 the number of accidents is presented, followed by the different accidents rates in working hours and while commuting. These rates were calculated by gender, sector of activity, and seriousness.

Different factors were analysed, through the study of the distribution of the accident frequency, in an effort to unearth what, who, how, when and where accidents in working hours and accidents while commuting take place. Among the factors under analysis, we find the gender of the worker involved in the accident, their post, the size of the firm and the injury suffered by the worker. In this accident frequency analysis, the most relevant percentages of accidents at the normal place of work, at other workplaces and when traveling during working hours are highlighted.

Statistical Analysis

The studies were done with contingency tables, in which the chi squared (χ^2) statistic was calculated to test the null hypothesis or the independence of the variables under analysis with regard to the type of accident. This statistic will show the possible influence of the different variables on the type of accident that is suffered. The corrected standardized residuals (csr) were obtained, placing an asterisk after those with a value lower than 1.96 in absolute terms, which do not therefore reach the significance level of 95% that is sufficient to reject the hypothesis of the independence of the variables. We can state that there is more than a random influence for those crs values that are over 1.96.

All analyses were calculated using the SPSS V20 statistical software package.

Results

As mentioned, two studies were performed. The first analyzed the evolution of accidents and, furthermore, studied the incidence rates of the accidents that occurred during both working hours and while commuting. The second study looked more deeply at the observed differences in the accident frequency distribution that occurred during the working day and while commuting.

Figure 1. Axis on Different Scales. Number of Accidents in Working Hours & While Commuting: Spain 1990-2010

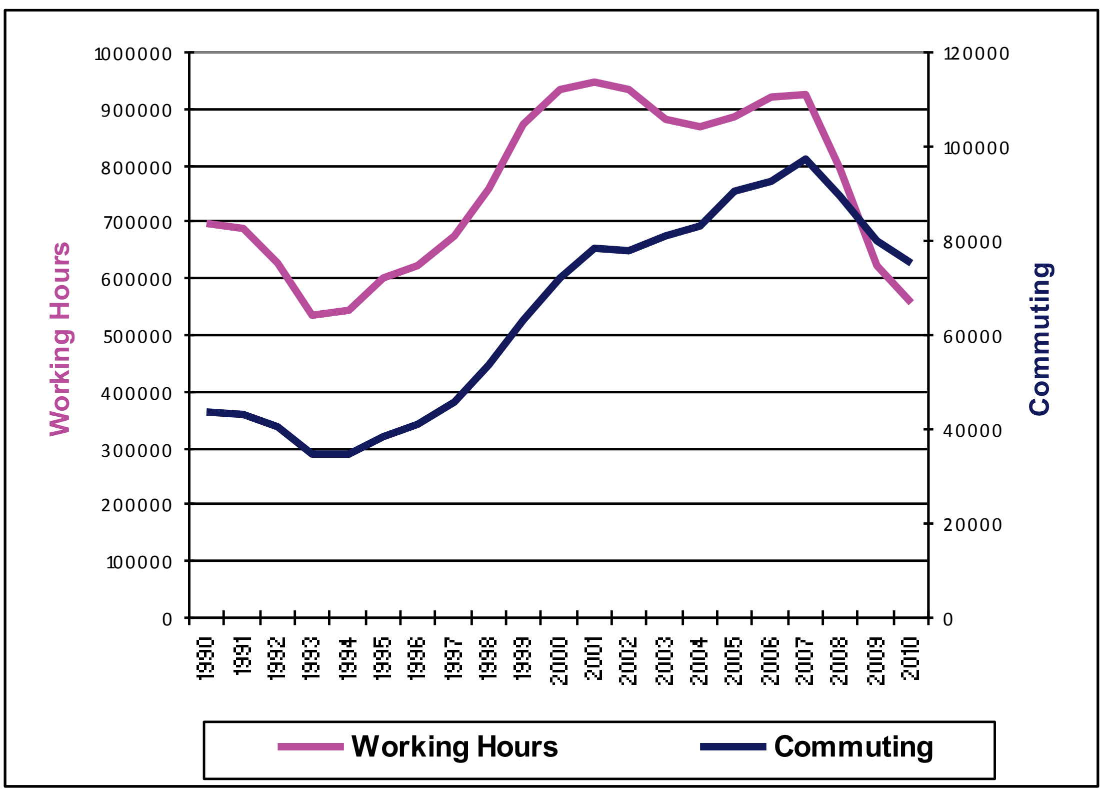
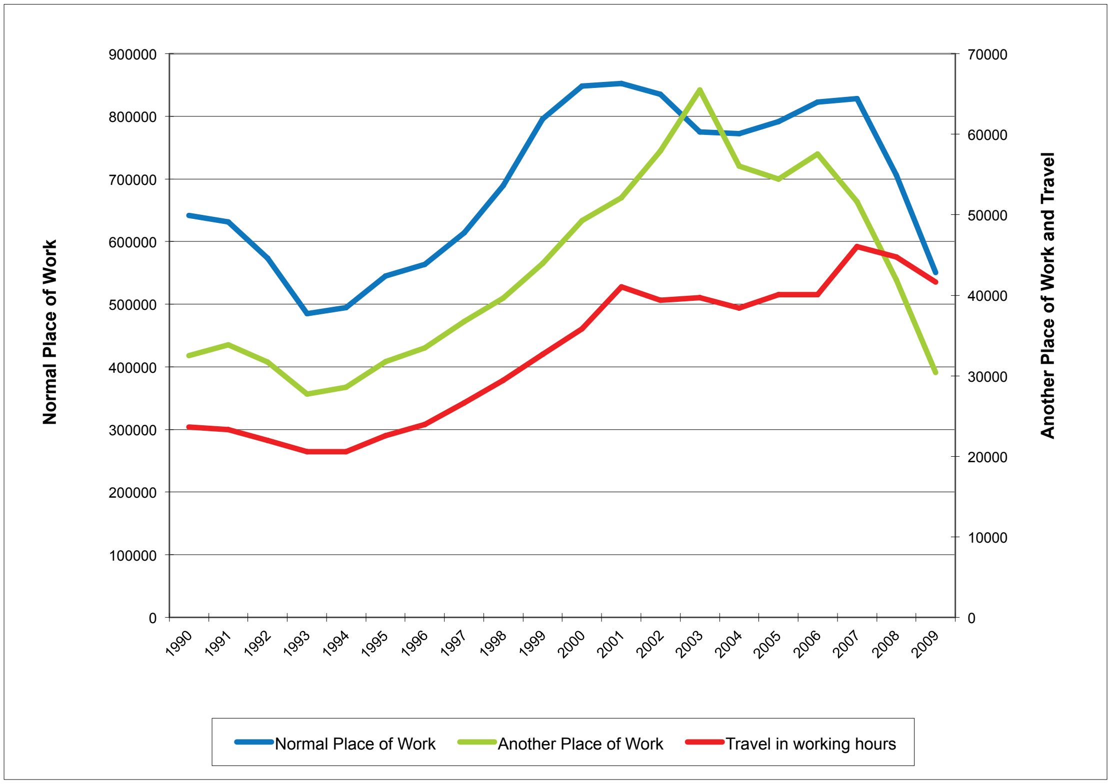


Figure 2. Axes on Different Scales. Number of Accidents in Working Hours: Spain 1990-2010



Evolution of Accidents & Incidence Rates

Over recent years, accidents during working hours and while commuting have evolved in the way that is shown in the double axis Figures 1 and 2. In Figure 1, it is seen that accidents in the working day and while traveling present similar curves, although the increases in commuting accidents were greater and the falls less so. Thus, if we take 2007 as our reference, at the start of the economic crisis that has been affecting Spain, we find that accidents during working hours fell by 39.6%, however, accidents while commuting did so by 22.5%.

In Figure 2, it may be seen that the largest number of accidents during working hours occurred at the normal place of work. Accidents at another place of work other than the normal one, presented the largest decrease with falls a close second and accidents while traveling during working hours having the least amount of decrease. In fact, between 2007 and 2010, accidents at the normal place of work fell by 40.9%, accidents at another place of work by 47.3% and, nevertheless, accidents while traveling during working hours only fell by 8.1%.

Moreover, Spain has seen a decrease in the salaried workforce paying social security. This workforce was 15,502,409 in 2006, but 14,712,877 in 2010. The general incidence rate rose from 65.3 per 1,000 workers in 2006 to 43.1 in 2010. In Table 1, the annual incidence rates are listed both for work-time accidents and commuting accidents for all the productive sectors. The accident rates are not calculated at the normal place of work, at other places of work, or while traveling during working hours, because of the impossibility of establishing the denominator for those rates.

Likewise, both the serious and the fatal accident rates were calculated per 100,000 workers, with the objective of establishing the probability of suffering a serious or fatal accident in each productive sector, both for work-time accidents and for commuting accidents, in the agricultural, industrial, construction and services sector.

A falling trend was confirmed in all sectors, both for accidents in working hours and while commuting; however, the probability of suffering an accident in working hours fell more than the probability of suffering one while commuting. In fact, from 2006 to 2010, the accident rate during working hours fell 36.0%, as against 15.0% recorded for the accident rates while commuting. It is of interest to observe that this fall varied substantially, in accordance with the productive sector. So, the primary sector decreased 7.8% during working hours and 18.8% when commuting, while the decrease was 40.5% and 34.8% in the industrial sector; 31.9% and 27.9% in the construction sector, and 25.4% and 8.1% in the services sector, respectively. Note that in the agricultural sector, the probability of suffering an accident while commuting was five times lower than in the other sectors.

Furthermore, the probability of suffering a serious or fatal accident fell over the five-years from 2006-10. The incidence rate of serious and fatal accidents during working hours fell by 40.1%, with the largest decrease in the industrial sector (41.8%) and the lowest reduction in the primary sector (13.2%). In commuting accidents, the incidence rates of serious and fatal accidents fell by 35.6%. In this case, the largest decrease was recorded in the construction sector (49.6%) and the smallest reduction in the services sector (28.2%). Curiously, for commuting accidents, the incidence rates for serious and fatal accidents recorded in the construction sector were higher than in the industry and services sector, although its accident incidence rates, for all commuting accidents, were lower.

Table 1 also displays the incidence rates for men and women in working hours and in commuting accidents. Over the years, the incidence rate among men is twice that recorded for women for accident rates in working hours. On the contrary, the incidence rate of commuting accidents has always been higher among women. Accident rates by gender cannot be calculated at the normal place of work, at other places of work and while traveling during working hours because it is impossible to establish the number of workers involved.

Risk Factors for Work-Time Accidents & for Commuting Accidents, 2006-10

An analysis of the frequency accidents in working hours and while commuting was adjusted by different risk factors. Equally, reference was made to accidents that occurred at the normal place of work, at another place of work, and when traveling during working hours.

Table 2 (p. 247) shows the accidents in working hours and while commuting with their respective percentages adjusted by the different risk factors and the characteristics of the accidents under analysis. So, we can see the frequency of the serious accidents in working hours and while commuting, the type of accident suffered by men and by women, and the occupations of injured workers in each type of accident. Moreover, the average age is shown in this table, the average length of service in months of the worker involved in the accident, as well as the average number of days of sick-leave taken by the worker and the average cost in Euros of each type of accident.

The average length of service was recorded for commuting accidents. Analyzing the type of accident and length of service by sections ($\chi^2 = 9085.865$; g.l.: 12; $p < 0.001$), it was confirmed that for every 100 accidents suffered while commuting, 19.3% involved workers with less than 3 months service (csr: -14.3) and 13.4% were workers with a length of service of more than 10 years (csr: 19.7). Moreover, commuting accidents recorded the most days off and the highest economic cost.

The average age of injured workers fell considerably in commuting accidents in all sectors of activity. The average experience varied notably from one sector to another. Besides, accidents suffered while traveling involved a much lengthier recovery period than accidents in working hours, with the same applying to economic compensation.

Sectors

Less than 7% of accidents at work in all sectors of activity occurred while commuting, except in the services sector that recorded 14.7%. Analyzing the type of accidents in working hours ($\chi^2 = 236682.646$; g.l.: 9; $p < 0.001$), the higher percentage of accidents recorded at the normal place of work may be confirmed in all sectors, although the primary sector and the industrial sector stand out more than any others with 88.8% (csr: 93.8) and 87.7% (csr: 224.4), respectively. Accidents at another place of work, other than the normal one, stand out in the construction sector, at 10.7% (csr: 298.6). Finally, the percentages of accidents while traveling in working hours stand out in the services sector at 7.4% (csr: 222.7).

The shortest recovery time occurred with accidents at the normal place of work and, in particular, in the industrial sector (22.5 days). Curiously, accidents at the normal place of work in the industrial sector were also those with the highest level of compensation [€939.9 ($1,068.21)]. Accidents with the longest recovery time were those that occurred when traveling in working hours in the agricultural sector (40.5 days), which also recorded the highest cost [€1,343.3 ($1,521.11)].

Table 1. Incidence Rate by Year & Industry (Accidents x 1,000 workers)

	2006	2007	2008	2009	2010
All	65,3	63,7	55,6	47,0	43,1
Working hours	59,4	57,7	49,9	41,7	38,0
Commuting	6,0	6,1	5,6	5,3	5,1
Agricultural sector	32,2	33,2	32,7	30,8	29,5
Working hours	30.6	31.5	31.2	29.4	28.2
Commuting	1.6	1.7	1.5	1.5	1.3
Industrial sector	105.5	101.9	90.0	67.8	63.2
Working hours	98.6	95.0	83.9	63.0	58.7
Commuting	6.9	6.9	6.1	4.8	4.5
Construction sector	130.4	126.1	107.4	96.3	89.0
Working hours	124.3	120.1	102.3	91.5	84.6
Commuting	6.1	6.0	5.1	4.7	4.4
Services Sector	46.0	45.2	41.1	37.8	35.4
Working hours	39.7	38.9	35.0	31.9	29.6
Commuting	6.2	6.3	6.0	6.0	5.7
Incidence rate of Serious and Fatal Accidents (Accidents x 100,000 workers)					
Total accidents	76.4	72.3	59.3	49.4	46.4
Working hours	61.8	58.6	47.7	39.2	37.0
Commuting	14.6	13.7	11.5	10.2	9.4
Agricultural sector	70.9	68.4	70.7	63.2	59.2
Working hours	62.9	60.7	64.3	56.7	54.6
Commuting	8.0	7.7	6.3	6.6	4.6
Industrial sector	110.3	105.3	87.3	65.8	63.4
Working hours	93.5	90.6	74.6	56.3	54.4
Commuting	16.8	14.7	12.7	9.5	9.1
Construction sector	184.4	176.7	145.6	124.7	125.0
Working hours	161.6	156.7	128.1	112.2	113.6
Commuting	22.8	20.0	17.5	12.5	11.5
Services Sector	46.7	43.9	37.0	34.6	32.7
Working hours	33.6	31.1	26.2	24.2	23.0
Commuting	13.1	12.8	10.8	10.5	9.4
Incidence rate by gender, Acc. x 1,000					
Working hours – Male	80.6	78.2	67.2	55.7	50.8
Working hours – Female	29.5	29.7	27.6	24.6	22.7
Commuting – Male	5.6	5.7	5.0	4.6	4.4
Commuting – Female	6.5	6.6	6.4	6.2	6.0

Seriousness

Commuting accidents were of greater seriousness (1.81%) than accidents suffered at the place of work (0.89%). In the analysis of the latter accidents ($\chi^2 = 15137.437$; g.l.: 6; $p < 0.001$), the percentage of serious accidents was 0.8% (csr: -97.5) and fatalities was 0.1% (csr: -69.9) at the normal pace of work. While accidents at another place of work, other than the normal one, these percentages rose to 2.2% (csr: 56.0) and to 0.3% (csr: 24.3), respectively. Finally, serious and fatal accidents while traveling in working hours were 1.9% (csr: 43.1) and 0.5% (csr: 52.2), respectively.

An analysis of the seriousness of road traffic accidents while traveling

Table 2. Accidents During Working Hours & While Commuting—Spain: 2006-2010

	Working hours (N= 3820803)		Commuting (N= 434775)			Average values - Working hours				Average values - commuting			
	Nº	%	Nº	%	csr**	Age	Recovery Time	Length of Service	Cost	Age	Recovery Time	Length of Service	Cost
Sector	Chi-squared = 96862.655	g.l.=3			p < 0.001								
Primary	161457	95.2%	8137	4.8%	-75.2	38.8	28.6	41.8	882.5	35.9	40.7	25.7	1293.3
Industry	935067	93.2%	68033	6.8%	-129.9	37.1	22.9	70.7	955.8	35.4	34.8	68.2	1462.1
Construction	914272	95.2%	45680	4.8%	-200.6	35.8	23.6	24.9	840.8	33.1	35.3	24.8	1273.4
Services	1809996	85.3%	312924	14.7%	307.4	37.2	23.9	51.6	872.0	35.9	34.3	54.8	1310.5
Firm size	Chi-squared = 32.354.230	g.l.= 3			p < 0.001								
Micro-Firm	756100	90.4%	80341	9.6%	-24.6	35.9	25.3	36.4	793.8	33.2	36.8	35.3	1088.2
Small Firm	1280446	91.8%	114062	8.2%	-102.4	36.4	23.1	43.4	824.2	34.1	34.2	42.4	1185.0
Medium Firm	989171	90.4%	104950	9.6%	-29.7	37.0	22.6	51.5	890.9	35.5	33.6	51.7	1307.7
Large Firm	741614	84.6%	134963	15.4%	174.9	38.4	24.1	68.4	1079.7	38.2	34.5	74.1	1614.9
Sex	Chi-squared = 130.528	g.l.= 3			p < 0.001								
Male	2919250	92.9%	221458	7.1%	-361.9	36.6	23.7	50.6	922.5	34.7	35.5	52.7	1448.9
Female	901553	80.9%	213317	19.1%	361.9	37.9	24.0	45.8	765.6	36.4	33.8	53.7	1206.5
Occupations	Chi-squared = 228.727.345	g.l.= 6			p < 0.001								
Directors and managers	13793	79.6%	3534	20.4%	44.4	42.7	33.2	91.0	1632.0	41.8	36.7	98.6	2253.5
Professionals and technicians	108464	69.8%	46997	30.2%	265.6	38.8	28.3	76.9	1475.3	36.9	35.1	68.9	1987.7
Supervisors	70393	94.0%	4497	6.0%	-38.4	42.2	27.1	84.8	1335.6	40.0	37.8	81.0	1960.8
Skilled workers	1613030	94.8%	88690	5.2%	-278.4	37.0	23.5	52.6	908.2	34.5	35.3	50.8	1369.2
Auxiliary staff and sales reps.	738949	79.9%	186107	20.1%	355.8	36.4	23.7	53.1	872.2	35.0	33.6	56.0	1231.2
Unskilled workers	1066932	92.0%	92542	8.0%	-93.1	36.3	22.9	36.3	738.1	36.3	35.2	38.8	1067.3
Drivers	195613	94.8%	10690	5.2%	-77.4	38.4	27.6	50.6	1007.9	36.2	38.4	50.0	1525.4
Seriousness	Chi-squared = 4.798.7459	g.l.= 2			p < 0.001								
Minor	3782929	89.9%	425567	10.1%	-67.3	36.9	22.8	49.4	848.0	35.5	32.7	53.1	1252.2
Serious	34101	81.2%	7873	18.8%	58.1	40.9	134.8	59.4	5131.5	38.2	144.0	58.7	5739.1
Fatal	3773	73.9%	1335	26.1%	37.6	43.9	2.8	70.3	108.7	38.3	3.3	52.6	116.8
Injured body part	Chi-squared = 606.741.949	g.l.= 7			p < 0.001								
Head	259410	96.4%	9781	3.6%	-116.5	36.7	13.4	44.4	505.0	37.3	30.6	56.3	1155.8
Neck	160265	55.4%	129018	44.6%	632.5	35.0	21.8	47.9	818.3	33.0	30.9	42.4	1150.8
Shoulder	715977	95.5%	34009	4.5%	-179.0	37.3	19.1	50.6	703.3	35.1	32.1	50.6	1224.4
Torso and organs	144030	91.6%	13288	8.4%	-23.6	40.0	25.2	57.6	999.1	39.9	37.9	67.0	1548.6
Arms	1357334	95.8%	60001	4.2%	-288.0	36.5	25.2	49.1	922.9	36.8	41.9	59.0	1627.4
Legs	1063461	89.5%	124340	10.5%	10.7	37.1	26.8	49.6	1009.0	37.5	33.7	63.9	1313.9
Multiple parts	90798	60.7%	58715	39.3%	377.6	38.1	34.4	49.3	1303.9	34.8	38.6	46.6	1499.0
Other parts	29528	84.0%	5623	16.0%	35.9	38.0	26.6	50.4	999.1	35.3	35.0	47.2	1284.3
Type of injury	Chi-squared = 110.372.171	g.l.= 13			p < 0.001								
Surface wounds	1388742	93.2%	101667	6.8%	-169.8	36.2	17.8	44.9	641.6	35.1	25.5	49.4	937.8
Fractured bones	239141	84.8%	43025	15.2%	91.3	38.9	61.7	54.4	2310.6	38.9	80.5	67.7	3217.7
Twists and sprains	1713436	88.3%	227266	11.7%	93.2	37.0	22.6	52.0	853.3	35.1	28.9	53.3	1102.7
Amputations	8831	98.2%	165	1.8%	-26.3	38.7	77.1	59.8	2851.0	37.9	86.7	50.6	3503.2
Internal injuries	195830	91.0%	19267	9.0%	-19.8	37.6	24.6	49.5	902.3	35.2	33.3	48.0	1199.2
Burns and freezing	54889	98.9%	585	1.1%	-71.7	36.4	18.1	47.4	685.7	36.3	25.5	48.3	1032.3
Poisoning	7548	99.6%	34	0.4%	-28.1	37.0	14.4	46.0	558.0	34.4	18.9	53.1	815.8
Suffocation and asphyxia	7072	98.3%	124	1.7%	-23.8	37.0	13.4	44.4	489.6	37.8	25.6	50.9	927.5
Effects of sound and vibration	4268	97.5%	108	2.5%	-16.9	35.9	18.8	52.3	799.7	40.8	25.4	70.3	1047.2
Effects of high temperatures	1844	99.8%	3	0.2%	-14.3	34.0	9.9	33.9	375.2	43.0	22.7	40.0	738.5
Psychological harm	6218	93.9%	404	6.1%	-11.1	38.0	34.0	60.7	1512.6	37.3	34.8	55.9	1382.5
Multiple injuries	39835	58.9%	27822	41.1%	267.6	38.0	42.9	49.2	1593.5	35.0	45.3	46.8	1809.9
Cardiac arrest and brain hæmorrhages	6630	94.4%	397	5.6%	-12.7	48.5	91.5	109.0	4523.8	47.6	62.7	121.0	3353.2
Other injuries	146519	91.3%	13908	8.7%	-20.9	37.6	22.7	52.4	842.3	35.8	32.5	52.4	1226.7
Was it a road traffic accident?	Chi-squared = 1.667.072.490	g.l.= 1			p < 0.001								
No	3713344	95.7%	168129	4.3%	-1291.2	37.0	23.5	49.7	874.2	38.8	31.2	68.7	1238.3
Yes	107459	28.7%	266646	71.3%	1291.2	34.1	34.5	42.4	1274.7	33.5	36.8	43.4	1387.8

in working hours and while commuting ($\chi^2 = 1522.051$; g.l.: 2; $p < 0.001$) confirms that both the seriousness and the fatality of the accident were much higher when they involved a road traffic accident rather than other sorts of accidents. So, 2.3% of every 100 road traffic accidents (csr: 32.9) were serious and 0.5% were fatal (csr: 20.7). In contrast, when the accidents were not road traffic accidents those percentages fell to 1.2% (csr: -32.9) and 0.2% (csr: -20.7), respectively.

The average age and the average length of service of the workers that have suffered accidents in working hours are directly related to the seriousness of the accident; the older the worker and the longer the service record, the greater the more likelihood of seriousness and fatality in the accident situation.

Analyzing only serious accidents in working hours, those with a shorter recovery time are seen to be those that took place at the normal work location, an average duration of 131.6 days, and those with a longer recovery time occurred while traveling in working hours, an average recovery time of 146.4 days. With regard to the average compensation, the lowest was found for minor accidents at the normal place of work [€826.3 ($939.10)] and the highest for serious accidents while traveling during working hours [€5,633.0 ($6,409.73)].

Road Traffic Accidents

One of the most widespread errors consists in supposing that all accidents while traveling in work-time or while commuting are due to accidents that involve vehicles, in other words, road traffic accidents. It may be seen from the analysis of the type of accident categorized as a "Road Traffic Accident" ($\chi^2 = 2068531.208$; g.l.: 3; $p < 0.001$) that 40.4% (csr: 531.1) of all accidents while traveling in working hours were road traffic accidents and 61.3% (csr: 1291.2) were commuting accidents.

In Spain, 5,108 fatal accidents occurred over the period 2006-2010, of which 1,892 ($\chi^2 = 12795.653$; g.l.: 2; $p < 0.001$; csr: 71.3) were traffic accidents. Of these accidents, 670 occurred while traveling in working hours ($\chi^2 = 178.660$; g.l.: 1; $p < 0.001$; csr: -13.4) and 1,147 (csr: 13.4) while commuting.

The average age and the average length of service of the workers involved in a road traffic accident was notably lower than those recorded for other types of accidents. Thus, 33.7 years and 43.1 months were recorded for the first type, as opposed to 37.1 years and 50.5 months for the second type of accident. The average number of days off work and their average cost was notably higher for traffic accidents, for which 36.1 days and €1,355.3 ($1,541.61) were recorded, as against 23.8 days and €890.0 ($1,011.44) recorded for the other accidents. If the recovery time and the cost of traffic accidents while traveling during working hours is compared with commuting accidents, commuting accidents are shown to have a longer recovery time (36.8 days) and a higher cost (€1,387.8 or $1,579.16) than traffic accidents while traveling in working hours [34.6 days; €1,270.6 ($,443.97)].

Gender of the Person in the Accident

Accidents by the gender of the person involved in the accident present significant differences when they are analysed by the type of accident ($\chi^2 = 148965.217$; g.l.: 3; $p < 0.001$). In fact, women suffered 24.4% (csr: -164.7) of all accidents at the normal place of work; 11.2% (csr: -160.0) of those at another place of work; 22.4% (csr: -40.9) of those while traveling in working hours; and, in confirmation of their higher incidence rate, 49.1% (csr: 361.9) of those accidents suffered while commuting to and from work involved women.

It is curious to see that the average age of women in the accidents was 37.6 years while the average age of men was 36.5. However, the average length of service was shorter among women (47.3 months) than among men (50.8 months). Moreover, the average number of days off work among men (24.5 days) was lower than the figure recorded for women (25.9 days), however, the average cost of accidents was €959.6 ($1,091.93) for men and was €850.0 ($965.98) for women. These differences are the same for all accidents during working hours. Thus, the average age of men involved in accidents at the normal workplace was 36.7 years and their average length of service was 51.4 months, which for women was 37.9 years and 46.2 months respectively.

In addition, the accidents suffered by men recorded an average duration of 23.0 days off work with an average cost of €894.8 ($1,017.81). While these same figures for women were 23.5 days off work at an average cost of €742.1 ($843.36). So, men involved in accidents at the normal place of work had an average age of 36.7 years and an average length of service of 51.4 months, while these same figures for women were 37.9 years and 46.2 months, respectively. Furthermore, accidents involving men recorded an average recovery time of 32.0 days off work, at an average cost of €894.8 ($1,017.81), while these figures for women were 23.5 days off work and €742.1 ($843.36).

Men involved in accidents while traveling during working hours had an average age of 36.2 years and a length of service of 53.6 months, while the average age of women was 37.8 and their length of service, 45.5 months. Moreover, accidents suffered by men had an average recovery time of 30.9 days and an average cost of €1,232.2 ($1,400/33), while these figures for women were 31.6 days off work, at a cost of €1.179.2 ($1,340.10).

Finally, the average age of men involved in accidents at another place of work, other than the normal one, was 36.2 years and their average length of service was 38.0 months, while these same figures for women were 38.2 years and 32.0 months, respectively. In addition, the average recovery time recorded for accidents suffered by men was 26.7 days off work at an average cost of €1,028.0 ($1,169.32), while these same figures for women were 25.0 days off work at an average cost of €748.7 ($851.94).

Occupation

In a comparison of occupation and type of accident ($\chi^2 = 418308.201$; g.l.: 18; $p < 0.001$), an analysis of the standardized residuals confirmed two perfectly defined tendencies, even though the highest percentages were recorded in all cases at the normal place of work. On the one hand, the occupations that recorded the highest standardized residuals for commuting and for travel during working hours and, on the other hand, those that occurred at the normal workplace and at another workplace. Thus, directors were found in the first group, registering percentages of 14.9% (csr: 59.5) for travel in working hours and 20.4%

(csr: 44.4) for commuting. The same may be said of professionals and technicians, who recorded percentages of 30.2 % (csr: 265.6) for commuting accidents, and 9.0% (csr: 72.2) for accidents while traveling in working hours. An identical tendency was confirmed for auxiliary personnel, assistants and sales representatives where the figures were 20.1 % (csr: 355.8) for commuting and 7.5% (csr: 119.8) for travel in working hours.

Moreover, supervisors, and skilled and unskilled workers presented their highest percentages at their normal places of work and at other places of work. Accordingly, supervisors recorded 84.9% (csr: 355.8) of their accidents at the normal place of work and 5.9% (csr: 355.8) at other places of work; and qualified workers, 85.6% (csr: 242.2) and 6.7% (csr: 140.2), respectively. Skilled workers recorded a high percentage of accidents at their normal place of work amounting to 87.7% (csr: 121.4) and drivers, logically enough, while traveling during working hours, at 21.0% (csr: 339.1). Curiously, drivers were one of the occupations with the lowest percentage of commuting accidents 5.2% (csr: -77.4).

The longest recovery times were recorded for accidents suffered by directors and managers (33.9 days). This occurred both for accidents at the normal place of work (31.5 days) and for accidents at another place of work (41.6 days). The greatest average age, service and compensation in all accidents was also recorded in that same group. In all the occupations, the accidents at another place of work have a substantially longer recovery time normal than those that occurred at the normal place of work. This fact appears to confirm that accidents at places of work other than the normal place of work are of greater seriousness and involve more fatalities than those at the normal place of work.

Drivers

The average age of drivers involved in accidents during working hours stands at 38.4 years and while commuting at 36.2 years. Accidents that involved drivers were analysed to know more about the age of the injured drives, of which 33,118 (16.1%) were road traffic accidents and 173,185 (83.9%) were other sorts of accidents. These percentages underwent considerable changes in the group of young drivers between 16 to 24 years old, which recorded 42.6% of traffic accidents ($\chi^2 = 11917.063$; g.l.: 5; $p < 0.001$; csr: 103.5).

Adjusting the accidents involving drivers as a function of their age and their gender, the highest percentage of traffic accidents among both men and women was found among the youngest. However, while this percentage among men was 41.8% ($\chi^2 = 11195.061$; g.l.: 5; $p < 0.001$; csr: 100.5), it was 57.5% ($\chi^2 = 392.666$; g.l.: 5; $p < 0.001$; csr: 18.6) among women.

Moreover, the highest percentage (89.5%) of road traffic accidents among all the fatal accidents suffered by the different age groups was also found among the youngest group of drivers ($\chi^2 = 53.419$; g.l.: 5; $p < 0.001$; csr: 2.3). This percentage progressively fell as a function of age, up to the eldest group of drivers who recorded 48.4% of road traffic accidents (csr: -4.2).

Finally, it may be highlighted that female drivers accounted for only 3 of the 683 fatal accidents suffered by drivers over the 2006-2010 period.

Size of the Firm

The size of the firm in which the person involved in the accident works also presented significant differences when compared with the type of accident. In fact, accidents while commuting, as can be seen in Table 3, recorded their highest percentage in large firms. When all accident types during working hours are related with the size of the firm ($\chi^2 = 41332.858$; g.l.: 9; $p < 0.001$), the percentages for large firms are also noteworthy, at 6.0% (csr: 49.0), in relation to accidents while traveling in working hours. The percentages for small firms may also be noted at 5.6% (csr: 30.9) in relation to travel in working hours. Moreover, the high percentages of accidents at the normal place of work stand out among small firms (81.6%; csr: 65.7) and at another place of work, other than the normal one, (5.5%; csr: 39.6). The medium-sized firm recorded similar percentages to these.

Accidents in micro-firms have the lengthiest recovery times, both at the normal place of work (24.3 days), in another place of work (30.2 days), traveling in working hours (34.2 days) and while commuting (36.8 days). However, in all cases, the highest costs were recorded for the large firm. The youngest age and the shortest length of service were also recorded for workers involved in accidents in micro-firms.

Injury

Injuries caused by accidents in working hours or while commuting may be seen in Table 2. In fact, comparing all these types of accidents with the type of injury that was suffered ($\chi^2 = 740561.930$; g.l.: 21; $p < 0.001$), it may be seen that there are two perfectly defined tendencies. On the one hand, injuries inflicted in accidents at the normal workplace and at another work site, and on the other hand, injuries inflicted while traveling in working hours and while commuting.

In the former, wounds and minor injuries may be highlighted, with 84.3% (csr: 169.4) at the normal place of work and with 5.0% (csr: 7.1) at other places of work. Fractures, however, recorded 72.4% (csr: -101.6) at the normal workplace and 6.0% (csr: 29.0) at other places of work. Burns were typical injuries at both (normal and other) places of work, with 91.4% at the normal place of work (csr: 68.2) and 5.5% at other work sites (csr: 7.0).

Important injuries may be identified in accidents while traveling in working hours and while commuting such as fractures, with 6.3% (csr: 31.2) while traveling in working hours and 15.2% (csr: 91.3) while commuting; multiple injuries with 16.2% (csr: 134.1) while traveling in working hours and 41.1% (csr: 267.6) while commuting; and, finally, minor injuries stand out such as twists and sprains, which account for 5.5% (csr: 39.7) of accidents while traveling in working hours and for 11.7% (csr: 93.2) while commuting.

Injuries involving the highest costs were heart attacks, amputations, and fractures. Moreover, the average age and the average recovery time of the most characteristic injuries confirms that injuries at a younger age and with an average recovery time were caused by extreme temperatures, and those at an older age with an average recovery time were recorded for heart attacks and brain hemorrhages.

The injured body part ($\chi^2 = 740561.930$; g.l.: 21; $p < 0.001$) also provided important information. Thus, higher percentages of injuries to the head were recorded at the normal place of work (86.7%; csr: 91.5) and in another place of work, other than the normal one (6.5%; csr: 39.9). The higher percentages of injuries to the neck occurred while commuting (44.6%: csr: 632.5) and while traveling in working hours (13.1%; csr: 204.3). The higher percentages of injuries to the shoulder 87.0% (csr: 171.0) and arms 87.9% (csr: 294.9) were recorded at the normal place of work.

Finally, the percentages of injuries to the legs may be highlighted in accidents while traveling in working hours (5.6%; csr: 31.6) and at another place of work, other than the normal one 5.2% (csr: 23.2). In all accidents, the older average age and length of service was recorded for workers that had injured the torso and abdominal organs, and the youngest average age in workers that had suffered injuries to the neck. The longest average recovery time was recorded for accidents involving injuries to multiple parts of the body and the shortest for injuries to the head.

Discussion & Conclusions

The probability of suffering an accident in working hours has been confirmed by this study be much greater than the probability of suffering an accident while commuting. This difference varies notably within each productive sector. Thus, the probability, in 2010, of suffering an accident in working hours, in the services sector, was 5 times greater than when commuting, while it was 22 times greater in the agricultural sector.

In Spain, it is estimated that 80% of workers take less than 30 minutes to commute to work. By sector of activity, construction workers have the longest commuting trips, followed by services, agriculture and industry (VII ENCT, 2011). However, the greatest probability of suffering an accident while commuting was in the services sector, followed by industry, construction and agriculture.

The probability of suffering a serious or fatal accident was also higher in working hours than when commuting in all productive sectors, but these differences differed considerably. From the results of this study, we can conclude that in the services sector, the probability of suffering a serious or fatal accident in working hours is greater than while commuting and either greater in the agricultural sector. These differences should be investigated in greater depth, as should the fact that workers in the construction sector had the highest probability of suffering a serious or fatal accident while commuting.

In Spain, employees from large firms have the longest commute time to work. In fact, more than 28% of workers in large firms spend 30 minutes or more on each commuting journey, while only 15% of workers in micro-firms use that time (VII ENCT, 2011). This might influence the fact that in Spain, 15.4% of accidents suffered by workers in large firms occurred while commuting, whereas this percentage stands at around 9.6% in small firms.

Road traffic accidents represent a high percentage of fatal occupational accidents. These percentages vary from 25% in the U.S. to 60% in France. In Spain, it was confirmed that 37% of fatal accidents were due to road traffic accidents. In fact, 85.9 of every 100 fatal accidents suffered while commuting were due to road traffic accidents. Companies in Spain need to focus on reducing road traffic accidents for their workers commute to work as well as driving during work hours.

A theme for debate is related to the age of the people involved in road traffic accidents in working hours. Some authors consider that older drivers are exposed to greater risk (Harrison, 1993; Boufous, 2009), while others consider that the youngest drivers are characterized by excessive confidence that increases the risks (DeJoy, 1985, 1991; Lichtenstein, 1978). Other authors consider that young men display higher risk behaviors and attitudes than women (Laapotti, et al., 2001; Parker, et al., 1995). In our study, the average age of road traffic accidents in working hours (34.1 years) was much lower than that recorded for other occupational accidents (37.0 years). Road traffic accidents represented 16.1% of all accidents suffered by drivers, however those percentages rose to 41.8% among drivers between 16 and 24 years old, and to 57.5% among female drivers between 16 and 24 years old.

In the scientific literature, we find numerous contributions that confirm significant differences between the accident rates and percentages of men and women. In our study, 19.1% of all accidents suffered by women occurred while commuting, whereas this figure stood at 7.1% for men. This important difference may be because women have more commuting accidents or have fewer accidents in working hours due, among other possible reasons, to vertical and horizontal segregation (Alamgir, 2009; Kelsh, 1996; Lin, 2008; Lindquist, 1999).

However, there is one unquestionable fact, which is that while the incidence rate of accidents in working hours is very much higher among men; curiously, the incidence rate in commuting is higher among women. Besides, 61.3% of commuting accidents were road traffic accidents and 38.7% occurred while walking. Even though we conclude that the gender plays a mixed role in the road traffic accidents related to the work setting, we believe that more in-depth research is necessary particularly behind the reasons that there is a greater probability of women suffering accidents while commuting.

Some authors have confirmed that compensation for road traffic accidents is greater than compensation for other accidents (Salminen, 2000). In Spain, the average compensation package is greater for commuting accidents, but this is not so for the total compensation package. In fact, in 2010, the average cost of accidents suffered at the normal place of work, or at another place, stood at €1,045.76 ($1,189.97), which led to a sum total that year of €540,305,918.37 ($614,030,660.93) in compensation. A total amount of €102,474,734.35 ($116,561,936.08) was expended on road traffic accidents while at work and the average cost per accident stood at €1,587.28 ($1,806.15). Because the total cost of road traffic accidents is so large and affect the bottom line of most companies in Spain, strategies towards reducing such cost have to be developed and implemented.

The highest average costs in accidents during working hours were recorded for accidents in the industrial sector (€955.8 or $1,087.60), although their average recovery time was the shortest (22.9 days). Perhaps the fact that the greater average length of service (70.7 months) was recorded for workers involved in accidents in industry has an influence on that higher cost. A similar situation occurred with commuting accidents.

By worker gender, the average cost for the compensation of accidents was higher for men than it was for women, both in working hours (20.5% higher) and while commuting (20.1%). However, the average duration of accidents was 5% higher among men for accidents in working hours, and 1.3% greater in women for accidents while commuting. The average length of service does nothing to clarify these differences, as it is 10.5% longer in accidents suffered by men in working hours and 1.9% shorter in commuting. The explanation for these differences may be found in the differences in salary between men and women, because the daily compensation by accident is calculated on the basis of the salary. So, women in the European Union earned lower salaries (17% less) than men (EU-OSHA, 2011). In Spain, in 2010, the average annual salary for men was €25,479.74 ($28,956.45), while women received an average salary of €19,735.22 ($22,448.22) (INE, 2012).

By firm size, the average costs of accidents inflicted in large firms during working hours exceeded those in micro-firms by 36.0%. The commuting accidents of large firms exceeded the micro-firms by 48.4%. Curiously, the average accident recovery time was longer in the micro-firm: in short, 4.7% in accidents in working hours and 6.3% in commuting. The differences in costs may be seen to be influenced by the average length of service of the workers involved in the accidents; because a lengthier service record could lead to a higher salary. This length of service was 87.9% longer in large firms, for accidents in working hours, and was 109.9% longer for commuting accidents.

From the data, we can conclude that the probability of having an accident as well as the probability of suffering a serious or a fatal accident makes a greater impact during working hours than while commuting. However, when we view the analysis of the frequencies of serious and fatal accidents, commuting accidents are found to be of greater seriousness and to involve more fatalities than accidents in working hours. Moreover, the high degree of seriousness of those accidents suffered at a place of work other than the normal one should be highlighted (2.2%), being much more serious than those recorded at the normal place of work (0.8%) and even for those accidents while traveling during working hours (1.9%). This is another good reason why companies should consider all aspects of road traffic accidents to be important and work towards programming to reduce such problems.

Furthermore, the seriousness of accidents was greater in road traffic accidents, as was expected. In fact, the percentage of serious (2.3%) and of fatal (0.5%) accidents while traveling during working hours and while commuting due to road traffic accidents was far higher than the percentages recorded for accidents that were not caused by road traffic accidents: 1.2% and 0.02%, respectively. We can conclude from these results that in spite of what is common thinking, road traffic accidents needs to be a bigger focus by companies in Spain (and elsewhere too) than it is currently.

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This study could have certain limitations:

1). It appears from this study, something that is confirmed in the European Union report (OSHA, 2011), that women tend to work in part-time occupations more than men. However, no reduction has been applied, to compensate for part-time workers when determining accident rates.

2). Accidents in the primary sector were not taken into account, as most of the accidents in this sector (76%) occurred to workers insured under the Agrarian Special Scheme. In other sectors, 1.3% of accidents in the industrial sector, 1.8% in the construction and 2.6% in the service sector were not included, as they were part of other schemes.

This information should serve to gain a greater understanding of accidents that occur in working hours and while commuting, so that companies can prepare more effective accident prevention plans in the fight against workplace accidents no matter where they occur. ✪

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Modeling the Dimensions of Ethical Leadership & Safety Climate in Aviation & Healthcare

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Abstract

Data from 837 employees in the aviation and healthcare industries was used to validate a model that predicted safety-related events and the effect of ethical leadership and ethical workplace climate on the organization's occupational injuries when safety climate was controlled for in the model. To assess the difference between employment samples, an ANOVA was conducted; significant differences at both the item level and the factor level existed; however, the model fit was not significantly different between the aviation and healthcare samples. Structural equation modeling was used to validate the hypothesized model; an unmediated path was found between the constructs of ethical leadership and occupational injuries that improved model fit and possessed greater weighting than a hypothesized mediated path. Highly weighted paths between the ethical workplace climate and safety climate constructs were also present in the model. Together, these findings demonstrate that perceptions of an ethical workplace climate can yield significant impact upon an organization's safety culture while workplace perceptions of ethical leadership are directly related to safety outcomes. This relationship provides a novel method for the prediction and mitigation of potential workplace mishaps.

Keywords
safety ethics, ethical leadership, aviation safety, healthcare safety, workplace climate

Introduction

The literature suggests that ethical leadership is thought to be important because of the outcomes it is believed to influence. Despite this suggestion influence in the literature, no studies exist in the literature that examines the relationships among ethical leadership and safety-related outcomes. Brown and Treviño (2006) proposed that ethical leaders would influence ethics-related conduct, such as employee decision-making, pro-social behaviors, and counterproductive behaviors, primarily through modeling and vicarious learning processes. Treviño, et al. (2003) and Treviño, et al. (2000) found that leaders' behaviors reflecting a concern for people and fair treatment of employees contributed to perceptions of ethical leadership while Avolio (1999) offered a different view of ethical leadership as going beyond fair treatment to include principled decision-making. Considerate and fair treatment of followers was found to correspond with ethical leadership, but not completely (Treviño, et al., 2003).

Victor and Cullen (1988) suggested that ethical workplace climates tend to vary along two distinct dimensions: ethical criteria, the reasoning process by which ethical decisions are made; and the focus of the ethical reasoning, which identifies the scope of ethical issues under consideration. Sims (2000) and Sims and Brinkman (2002) describe how leaders shape and reinforce the ethical climate of an organization through ethical leadership. While the literature articulates different processes by which a leader's ethical approach affects an organization's ethical climate, leaders have substantial power a) to create and maintain ethical norms and processes; and b) to create a particular kind of ethical climate. Victor and Cullen (1988) referred to the organization's ethical climate at the workplace level. At the workplace level, the relationship among a) climate and incidences of injuries; and b) climate and safety motivation can be discerned more clearly. This relationship represents a condition that is within the organizations' ability to change.

Transforming leaders inspire followers by aligning their own and their followers' value systems toward important moral principles (Burns, 1978). Bass and Avolio (1993) describe transformational leaders as role models (i.e., as examples to be followed) and as demonstrative of "high moral and ethical conduct" (Avolio, 1999, p. 43). Their findings suggest that transformational leadership plays a positive role in increasing collective efficacy among followers, which in turn has a positive impact on job satisfaction and commitment. The leadership construct used in this study reflects the manner in which leaders applied ethical leadership in the workplace, that is, transformational leadership. Barling, et al. (2002) described each of the four components of transformational leadership as relevant to improving workplace safety.

Researchers have examined the predictors of safety climate and suggest that positive safety climates are created when leaders demonstrate a commitment to safe practices and policies within an organization (DeJoy, 1985; Zohar, 1980). Perceptions of safety

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climate are "shared perceptions of managerial policies, procedures and practices," (Zohar, 2002, p. 75) relating to safety. Hofmann and Stetzer (1996) note that these shared perceptions influence the employees' actions and safety behavior in the workplace. Barling, et al. (2002) found that perceptions of safety climate mediated the relationship among transformational leadership style and safety-related events, which in turn predicted occupational injuries. Zohar (2000) provided evidence for the group-level model of safety climate and the prediction of injuries as opposed to organizational policies and procedures concerning safety.

Neal and Griffin (1997) proposed a model of safety performance that distinguishes between two dimensions of safety behavior: safety compliance and safety participation. Safety compliance involves carrying out required behaviors that maintain workplace safety, such as following safety procedures and wearing protective safety equipment. Safety participation involves behaviors that indirectly contribute to developing a safe work environment, such as employee initiative to voluntarily participate in safety activities and programs (Cree & Kelloway, 1997). Although important safety policies and training programs are legislated in the United States, the legislation does not ensure that employees will comply with the policies or wear the appropriate safety equipment (Mullen, 2004). Accordingly, an individual's willingness to voluntarily participate in an organization's safety procedures becomes central to improving workplace safety.

Leaders who act consistently in a safety-specific transformational manner do so by communicating high expectations regarding safety, show an interest in the safety of employees, and encourage employees to develop innovative ways to improve current safety practices that contribute to the enhancement of perceived safety climate and increased safety performance (Barling, et al., 2002). High quality leader-member relationships are associated with less safety-related accidents in the workplace (Hofmann & Morgeson, 1999). Barling, et al.'s (2002) findings also support the claim that individuals reciprocate high quality relationships with their leader by adopting greater safety participation.

The purpose of this study was to develop and evaluate a model linking ethical leadership and an ethical workplace climate with measurable safety outcomes expressed as occupational injuries. The model was based on the assumption that ethical leadership and ethical workplace climate are distinct constructs. Given the importance of ethical leadership for its ability to influence workplace outcomes, the ability of organizations to influence ethical workplace climates, and the ability of safety culture to influence safety outcomes, this study sought to link these ethical constructs with safety-related events and occupational injuries to determine if employee perceptions of these ethical constructs were related to safety outcomes.

Method

The study drew samples from two populations of workers in safety-sensitive positions of U.S. airlines and inpatient healthcare providers where there is a normative potential for exposure to common occupational injuries, as opposed to clerical and administrative positions. Helmreich and Merritt (1998) were among the first to draw comparisons between the high reliability organizations (HROs) of aviation and healthcare. Helmreich (2000) noted "in both domains, risk varies from low to high with threats coming from a variety of sources in the environment" (p. 720). Helmreich's work is grounded in human factors psychology; the Threat and Error Management (TEM) model is the basis of his work in crew resource management (CRM), organizations, and measures of safety (Helmreich, 2002; Helmreich, Klinect & Wilhelm, 1999). Based on previous research by Perrow (1982), and Weick and Roberts (1993), HROs can be defined as organizations that have fewer than normal accidents. This decrease in accidents occurs through change in culture (Weick & Roberts, 1993). To strengthen the generalizability of the findings, these two distinct and separate employee groups were examined (Brady, 1986).

Structural equation modeling (SEM) was used to validate the hypothesized models and to assess the broader dimensions of safety culture. The sample size obtained influences the generalizability of the final model. Westland's (2010) statistical algorithm to compute the lower and upper bounds of the sample size in SEM was used. The algorithm was applied in a meta-study comprising 74 research studies using SEM. Westland concluded that 53% of studies in this sample used sample sizes that fell below the algorithms computed lower bound for their models. The lower bounds computed are less than or equal to the absolute minimum sample sizes. Significance was set to a default of 0.05, as suggested by Fisher (1925), and power was set to 0.8, as suggested by Cohen (1988). Therefore, application of the algorithm to the hypothesized model for this study yielded a requirement for the hypothesized model of a minimum sample size of 87 to detect effect and a minimum sample size of 400 to detect the model's structure. The minimum sample size of 400 respondents (Westland, 2010) was obtained in order to ensure detection of both effect and model structure.

The instrument was electronically distributed to 6,263 individuals who met the criteria for inclusion and constituted the population of the study. Of these, 2,613 were employed in the aviation domain and 3,650 were employed in the healthcare domain. The response counts and rates are shown in Table 1. All incomplete responses were deleted casewise and removed prior to any analysis. As more than 400 responses from both aviation and healthcare populations were received, independent models were assessed for each population in addition to the modeling of all responses from both HROs together. The following seven constructs were examined:

1) Ethical leadership. Ethical leadership was assessed using Craig and Gustafson's (1998) 31-item scale of perceived leader integrity. Examples of the items include "My supervisor can be

Table 1. Response Rate

Population	Distributed	Incomplete	Valid	Response Rate
Aviation	2,613	58	413	15.81%
Health Care	3,650	104	424	11.62%
Total	6,263	162	837	13.36%

Table 2. Reliability Testing

Scale	Cronbach's alpha	*N* of items
Ethical leadership	.869	31
Ethical workplace climate	.773	26
Safety climate	.772	10
Safety participation	.789	4
Safety compliance	.832	4
Safety-related events	.855	16
Occupational injuries	.819	8

trusted," and "My supervisor lacks high morals." Respondents indicated their agreement with the statements on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

2) Ethical workplace climate. Ethical workplace climate was assessed with Cullen, Victor and Bronson's (1993) 26-item ethical climate scale. Examples of the items include "In my workplace, people are only concerned for themselves," and "In my workplace, people comply with the law." Respondents indicated their agreement with the statements on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

3) Safety climate. Safety climate was assessed with a 10-item short form of Zohar's (1980) safety climate scale. Examples of the items include "My boss is willing to invest money and effort to improve safety in this job," and "Workers who work safely have a better chance of promotion here." Respondents indicated their agreement with the statements on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

4) Safety participation. Safety participation was assessed using Neal, et al.'s (2000) four-item safety participation scale. Examples of the items include "I promote safety within the organization," and "I put in extra effort to improve the safety of the workplace." Respondents indicated their agreement with the statements on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

5) Safety compliance. Safety compliance was assessed by Neal, et al.'s (2000) four-item safety compliance scale. Examples of items include "I use all the necessary safety equipment to do my job," and "I use the correct safety procedures for carrying out my job." Respondents indicated their agreement with the statements on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

6) Safety-related events. Safety-related events were assessed using a 16-item scale developed by Barling, et al. (2002). Items include "While performing my job I . . . 'had something fall on me,' and 'overextended myself lifting or moving things.'" Respondents indicated the frequency in which the events occurred on a seven-point scale ranging from 1 (rarely) to 7 (frequently).

7) Occupational injuries. Injuries were assessed with eight items developed by Barling, et al. (2002). The measure was based on Castillo's (1999) description of the types of injuries that young workers experience. Examples of injuries included strains or sprains, cuts or lacerations, and bruises or contusions. Respondents indicated the frequency in which the events occurred on a seven-point scale ranging from 1 (rarely) to 7 (frequently).

Results

Reliability Testing

Reliability was assessed using Cronbach's (1951) alpha for each of the constituent scales. These values are presented in Table 2. Reliability analysis of all responses (n = 837) across all seven scales computed simultaneously resulted in a value for alpha of .841 for an *N* of items = 99.

Factor Analysis

Factor analysis using principal component analysis with Varimax rotation was employed on the full dataset of aviation and health-care employment conditions for two purposes. First, two analyses were performed to ensure that the ethical leadership and ethical workplace climate constructs were separate and distinct, while also ensuring that safety climate, safety participation, and safety compliance were separate and distinct constructs. Secondly, each scale was factored independently to ensure that it represented the construct claimed, or to determine what sub-constructs may exist. The factors are listed in Table 3.

After rotation, the factor analyses demonstrated that the constructs of ethical leadership and ethical workplace climate loaded independently. The first factor, ethical leadership, accounted for 41.3% of the variance. However, ethical workplace climate loaded into four discrete factors. The first factor, EWC_{F1}, related to laws and codified regulations that apply to the work-

Table 3. Description of Factors

Construct	Name	Description
EL	Ethical Leadership	Ethical leadership items
EWC_{F1}	Ethical Workplace Climate, First Factor	Regulatory elements of ethical workplace climate items
EWC_{F2}	Ethical Workplace Climate, Second Factor	Idealized ethos elements of ethical workplace climate items
EWC_{F3}	Ethical Workplace Climate, Third Factor	Self-interest elements of ethical workplace climate items
EWC_{F4}	Ethical Workplace Climate, Fourth Factor	Personal morality elements of ethical workplace climate items
$SCli_{F1}$	Safety Climate, First Factor	Proactive elements of safety climate items
$SCli_{F2}$	Safety Climate, Second Factor	Reactive elements of safety climate items
SPar	Safety Participation	Safety participation items
SCom	Safety Communication	Safety communication items
SRE	Safety-Related Events	Safety-related events items
OI	Occupational Injuries	Occupational injury items

place, accounted for 12.2% of the variance. The second factor, EWC_{F2}, related to idealized concepts of ethical good beyond the self, accounted for 7.6% of the variance. The third factor, EWC_{F3}, related to ethical issues of self-interest, accounted for 7.1% of the variance. The fourth factor, EWC_{F4}, related an individual's sense of morality, accounted for 5.1% of the variance. The first three factors of ethical workplace climate were retained as discrete items for the remaining analyses. The fourth ethical workplace climate subscale, EWC_{F4}, did not yield any statistically significant paths among any of the mediator constructs, safety-related events, or occupational injuries during modeling of the dataset. As a result, the EWC_{F4} factor was removed from model construction and presentation for the sake of clarity in the iterative models that followed.

Factor analysis of the mediating and moderating constructs revealed that each construct was discrete from the others. After rotation, the first factor, safety compliance, accounted for 19.7% of the variance. The third factor, safety participation, accounted for 18.2% of the variance. The loading of the safety climate items revealed two independent factors. The first factor, $SCli_{F1}$, related to proactive safety climate issues, accounted for 18.5% of the variance. The second factor, $SCli_{F2}$, related to outcome-based safety climate issues, accounted for 16.8% of the variance. These four factors, SCom, SPar, $SCli_{F1}$, and $SCli_{F2}$, were retained as discrete items for the remaining analyses.

Analysis of Variance

A one-way between-subjects ANOVA was conducted on the full dataset to compare the effects of employment condition, aviation or healthcare, on the ten emergent factors of the previous analysis. There was no significant effect of employment condition on ethical leadership at the $p < .05$ level for the two conditions, $F(1, 835) = 1.986$, $p = .159$. There was a significant effect of employment condition on ethical workplace climate for the EWC_{F1} factor, regulations, at the $p < .05$ level for the two conditions, $F(1, 835) = 17.375$, $p < .000$, $\eta^2 = .021$, indicating a large effect. Healthcare had a significantly higher mean ($M = 5.47$) than aviation ($M = 5.05$). There were no significant effects of employment condition on ethical workplace climate for the EWC_{F2}, idealized ethos, or EWC_{F3}, self-interest, factors at the $p < .05$ level for the two conditions, $F(1, 835) = 1.855$, $p = .173$, and $F(1, 835) = .260$, $p = .610$, respectively.

Similarly, there were no significant effects of employment condition on safety climate for the $SCli_{F1}$, proactive, or $SCli_{F2}$, outcomes, factors at the $p < .05$ level for the two conditions, $F(1, 835) = .472$, $p = .492$, and $F(1, 835) = .314$, $p = .575$, respectively. Both safety participation and safety compliance demonstrated significant effects of employment condition on them at the $p < .05$ level for the two conditions, with $F(1, 835) = 6.859$, $p = .009$, $\eta^2 = .008$ for safety participation, and $F(1, 835) = 20.712$, $p < .000$, $\eta^2 = .024$ for safety compliance. Both of these relationships demonstrated a medium effect. Finally, there were no significant effects of employment condition on safety-related events or occupational injuries at the $p < .05$ level for the two conditions, with $F(1, 835) = 1.060$, $p = .304$ for safety-related events, and $F(1, 835) = .631$, $p = .427$, for occupational injuries.

Table 4. Standardized Regression Weights for the Combined Best-Fit Model

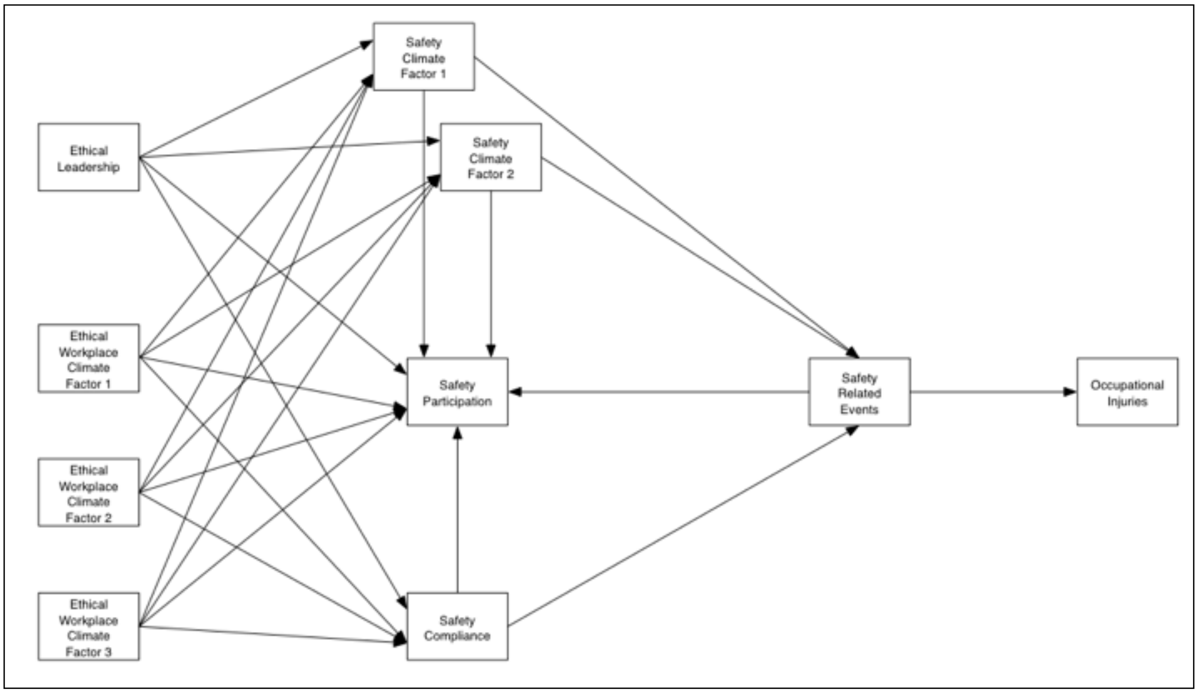
Factor	Path	Factor	Hypothesis	Estimate	S.E.	C.R.	*p*
EL	→	$SCli_{F2}$	2b	.226	.044	5.139	***
		SPar	3	-.149	.039	-3.792	***
		SRE	n/a	.095	.039	2.428	.015
		OI	n/a	.372	.029	13.029	***
EWC_{F1}	→	$SCli_{F1}$	5a	.413	.032	13.068	***
		SPar	6a	.278	.040	7.016	***
EWC_{F2}	→	$SCli_{F1}$	5b	.369	.030	12.510	***
		OI	n/a	.128	.028	4.553	***
EWC_{F3}	→	$SCli_{F2}$	5f	.362	.035	10.216	***
		SCom	7c	.118	.031	3.764	***
		SRE	n/a	.164	.040	4.132	***
$SCli_{F1}$	→	$SCli_{F2}$	n/a	.586	.132	-2.455	***
		SRE	9a	-.080	.037	-2.167	.030
$SCli_{F2}$	→	$SCli_{F1}$	n/a	.586	.130	4.587	***
		SPar	8b	.116	.044	2.635	.008
		SRE	9b	.097	.047	2.052	.040
SRE	→	SPar	12	.078	.035	2.227	.026
		OI	13	.371	.030	12.380	***

Model Revision

The use of factor analysis expanded the number of constructs for the SEM-PA from the initial seven to ten to account for the additional two factors for ethical workplace climate and one additional factor for safety climate. To assess the proposed models, the covariance matrix of the variables served as the input to the maximum likelihood estimation procedures of IBM SPSS Amos version 20. The initial, fully mediated model is shown in Figure 1. This model failed to produce an adequate fit, as evidenced by the fit indices: NFI = .752; CFI = .757; RMSEA = .155; CMIN = 379.500; *df* = 18.

Review of the modification indices suggested both additive and subtractive modifications to the model through four iterations. Adding a single path between ethical leadership and safety-related events without mediation created the fourth and final model revision. No other changes to model structure were made at that point and optimal fit was obtained, NFI = .954; CFI = .960; RMSEA = .073; CMIN = 70.058; *df* = 11. This minimally mediated model is shown in Figure 2 (p. 258) and represents the end-state model for the analysis. The standardized regression weights for the best-fit model are shown in Table 4.

Figure 1. Fully Mediated Model



Discussion

Analysis of Variance

Before modeling was attempted, testing was conducted to determine if there were significant differences between the two populations as distinguished by employment condition. A one-way between-subjects ANOVA was conducted at the item level, although a per-item discussion of differences was beyond the scope of this study, which was limited to investigating the differences between populations at the construct level. Accordingly, an additional one-way between-subjects ANOVA was conducted on the ten emergent constructs from factor analysis. Only three of these constructs had significant differences between populations: the first factor of ethical workplace climate, safety participation, and safety compliance. There was a significant effect of employment condition on ethical workplace climate for the EWC_{F1} factor, regulations, for the two conditions.

The first factor of ethical workplace climate, items related to laws, rules, and regulations, did vary significantly between groups with large effect. This factor is noteworthy as both aviation and healthcare are occupational fields subject to considerable external and internal regulation and no significant difference was expected in this factor. There were significant differences with medium effects between the groups for the mediators of safety participation and safety compliance; however, both of these constructs, when modeled, had comparatively low standardized regression weights, decreasing their relative importance in the model. The combined dataset was used to validate the results of the individual population model structures by providing a baseline model for HROs that is undifferentiated by workplace.

Model Revision

The initial, fully mediated model, shown in Figure 1, failed to produce an adequate fit. Iterative modifications were made to this model in order to improve fit. The two added and nine removed paths were largely the simplification of the relationships among ethical leadership and the mediating constructs as well as among the factors of ethical workplace climate and the mediating variables. This change from 16 to nine paths directed toward the mediating constructs, as well as a removal of paths between some of the mediators, greatly simplified the conceptual presentation of the model and improved model fit to near-acceptable levels. The final model provided the optimal fit indices for the dataset with any subsequent modifications decreasing overall fit. Of the 17 statistically significant paths in the final model, there are seven paths that are more highly weighted than the others and represent the strongest relationships among the constructs. These paths are shown in Figure 3 and are discussed individually.

1) Ethical leadership to occupational injuries. This path, while not part of the study's hypotheses, shows an unmistakably strong relationship between the constructs of ethical leadership and occupational injuries. The path had a coefficient value of .372 for the combined model, slightly higher for the healthcare model at .431, and lower than the combined model for aviation, with a coefficient value of .306. When leadership is perceived to be ethical by the employees, there are statistically significantly fewer occupational accidents. An ethical leader has provided a safe working environment through his/her policies, procedures, benefit packages, and most importantly his/her actions.

2) Ethical workplace climate (regulations) to safety climate (proactive). This significant path, with the highest direct regression weight in the entire model is intuitive; that is, that a relationship would necessarily exist between the regulatory aspects of an ethical workplace climate and a proactive safety climate. Because of the highly structured, codified, safety-oriented environments of aviation and healthcare this relationship was expected. The path had a coefficient value of .413 for the combined model, slightly lower for the healthcare model at .404, and even higher for the aviation model, with a coefficient value of .434.

3) Ethical workplace climate (regulations) to safety participation. The initial model identified four statistically significant paths to safety participation; however, only the path from the regulatory factor of ethical workplace climate had a significant path in the final model. The path from the regulatory factor of ethical workplace climate to safety participation had a coefficient value of -.149 for the combined model, slightly higher for the healthcare model at -.063, and much lower for the aviation model, with a coefficient value of -.223. The path's weighting indicates that safety participation may well be the result of fiat, not choice. The lack of a path from the other ethical workplace climate factors, ideals and self-interest, merits additional investigation.

4) Ethical workplace climate (ideals) to safety climate (proactive). Similar to the ethical workplace climate (regulations) to safety participation relationship, the path between the idealized aspects of ethical workplace climate and a proactive safety climate is also unsurprising. The path had a coefficient value of .369 for the combined model, slightly lower for the healthcare model at .289, and even higher for the aviation model, with a coefficient value of .382. For those tasked with the implementation, management, and assurance of safety in an organization, however, this relationship may be even more important. While the previous path reinforces the idea that good rules lead to good practices this path more clearly demonstrates the core of an effective safety culture: the idea that effective, proactive safety is based on principles nearly as much as it is on procedures.

5) Ethical workplace climate (self-interest) to safety climate (outcomes). As noteworthy as the path from the third factor of ethical workplace climate to outcome-based safety climate is it is the paths that are not present that merit discussion. A strong relationship between self-interest and outcomes is intuitive; however, this relationship is far from ideal for a manager attempting to build a positive, proactive safety culture. The path had a coefficient value of .362 for the combined model, slightly lower for the healthcare model at .287, and higher for the aviation model, with a coefficient value of .426.

Figure 2. End-State Model

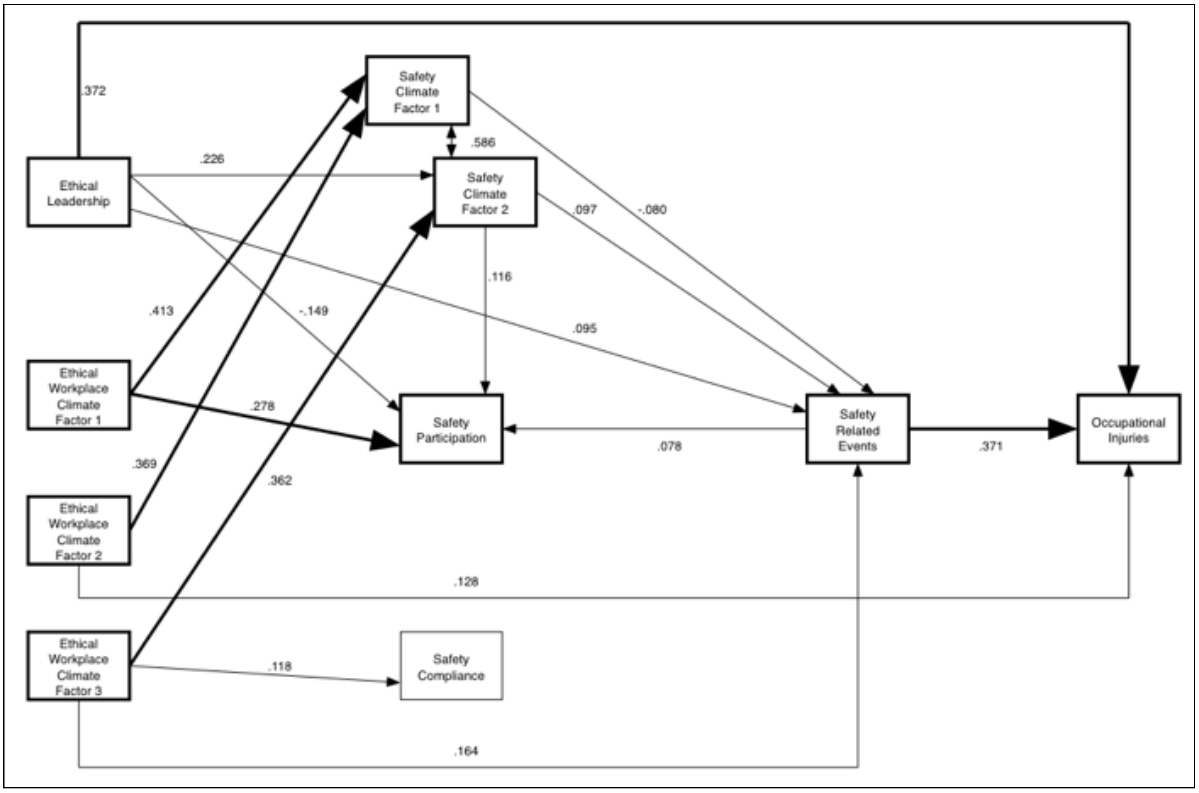
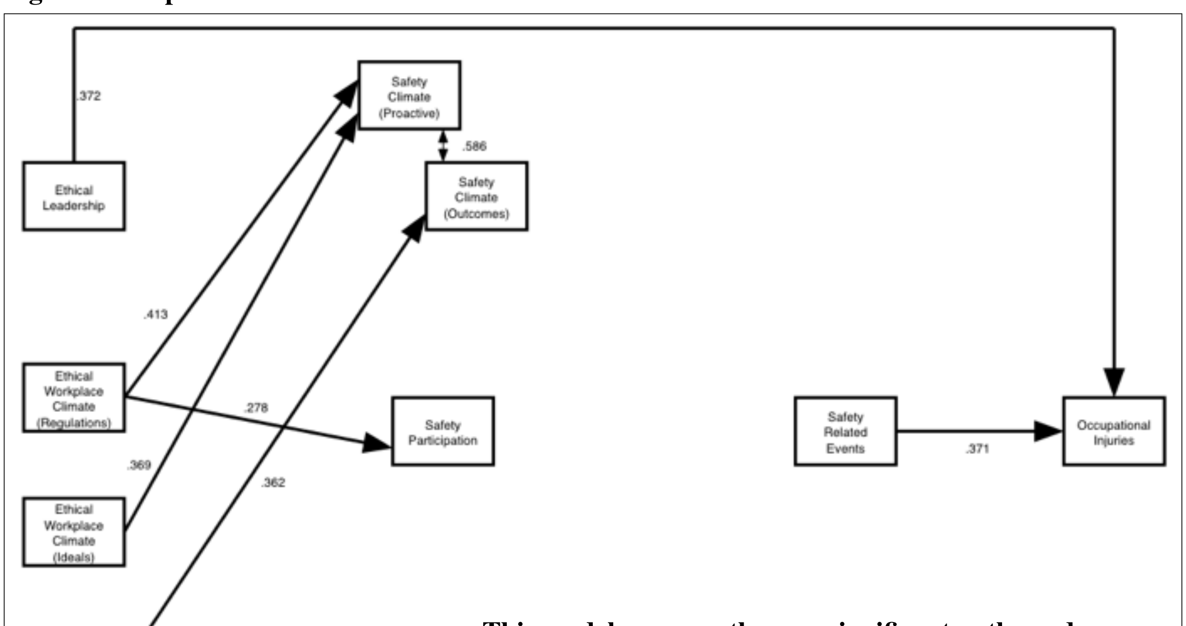


Figure 3. Simplified Model



This model removes the non-significant paths and highlights those paths with stronger relationships.

The lack of significant relationships between the ideals or self-interest factors of ethical workplace climate and safety participation is somewhat troubling for the safety professional. Safety participation appears to be solely a function of the regulatory aspects of ethical workplace climate; that is, safety participation is seen as something to be done by compulsion, not by choice. This same self-interest factor had the only statistically significant path to safety compliance, and even then it was among the weakest in the model. Again, compliance is occurring in the organization not because it is what is right for the individual, and not because it is accepted as a universal right but instead because it is ordered. This compliance is a victory for safety education—the employees see the personal safety implications of making the right choice; however, the ordered compliance does not speak well of the overarching safety culture for the organizations' participating.

6) Safety-related events to occupational injuries. The path from safety-related events to occupational injuries was hypothesized and the strength of the relationship was expected. The path had a coefficient value of .371 for the combined model, marginally higher for the healthcare model at .373, and even higher for the aviation model, with a coefficient value of .390. In a study by Barling, Loughlin and Kelloway (2002), the relationship was even stronger, with a path coefficient of .44, $p < .01$. This strength may be attributable to the population in their study that was not limited to high reliability organizations and focused on workers under the age of 25 in the restaurant and hospitality industries (Barling, Loughlin & Kelloway, 2002).

7) Safety climate (proactive) and safety climate (outcomes). The path from safety climate (proactive) to safety climate (outcomes) was not hypothesized and was the result of factor analysis identifying two distinct constructs. The path had a significant coefficient value of .586 for the combined model, a lower significant coefficient value for the healthcare model at -.818, and a non-significant coefficient value for the aviation model, with a coefficient value of -.037.

The path from safety climate (outcomes) to safety climate (proactive) similarly was not hypothesized and again was the result of factor analysis identifying two distinct constructs. The path had a significant coefficient value of .586 for the combined model, a higher significant coefficient value for the healthcare model at .822, and a lower significant coefficient value for the aviation model, with a coefficient value of .309. The safety climate literature extensively describes the relation between a proactive safety climate and an outcome-based safety climate (Cree & Kelloway, 1997; DeJoy, 1985; DeJoy, et al., 2004; Katz-Navon, et al., 2005). As a result, the strong bi-directional relationship between these two safety climate factors was not surprising once the factors were modeled.

The strong relationship between ethical leadership and occupational injuries provides an immediate and low cost mode of investigation and potential mitigation for senior management. The incorporation of ethical leadership items in workplace perception studies may provide early warning of employee perceptions that are strongly associated with negative safety outcomes and injury. These measures of perception can be made through both safety climate and job satisfaction surveys as a means of informing senior management of the potential for negative outcomes within a workplace unit before the events occur. The knowledge of employee perceptions of workplace ethical leadership allows for the deployment of administrative countermeasures—up to and including the replacement of the workplace level managers involved.

Further, these significant relationship pathways can be explored in reverse to great utility to determine appropriate causality post hoc. For example, if collected safety data showed an increase in safety-related events and/or occupational injuries, an assessment of ethical leadership and ethical workplace climate can be conducted—in addition to other measures—to determine the appropriate, or most effective, target for mitigation. A finding of strong ethical leadership and poor ethical workplace climate would suggest that organizational or cultural changes are indicated and that an effective leader is present in the workplace despite the overarching deficiencies in the organization itself. Conversely, low ethical leadership values accompanied by high ethical workplace climate values may indicate a localized problem with an individual leader and mitigated, as appropriate. Validation of these findings may be conducted by analyzing the variance between workgroups and the organizational totals for both the ethical constructs and the outcome constructs.

The results of this study provide support for the impact of both ethical leadership and ethical workplace climate perceptions on safety outcomes. Consistent with previous studies (Hoffman & Stetzer, 1996; Kelloway, et al., 2000; Kelloway, et al., 2006), ethical leadership as a form of transformational leadership, has an important effect on subordinate perceptions of safety climate, on subordinate perceptions of safety participation, and upon the rate of self-reported occupational injuries. Thus, empirical support is provided for the final, partially unmediated model suggesting that ethical leadership has a direct effect upon occupational safety outcomes in HROs. However, future research must continue to examine both the direct and indirect effects of both ethical constructs on occupational safety outcomes. ○

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The Social Representation of the Pedestrian in French & Asian Cultures

Sandrine Gaymard, Teodor Tiplica, Puay Ping Koh and Yiik Diew Wong

Abstract

Society's evolution is to be found in the development of friendly modes of mobility (walking or cycling) on environmental and health grounds (Lanzerdorf & Busch-Geertsema, 2014). A country's progress in this field depends on its history and other characteristics that are specific to the culture and the environment. In this study we were concerned with the social representation of the pedestrian connected to the cultural environment, that is, the place of living and the culture of the country. With this in view we started from a characterization questionnaire to compare this representation among two groups of students, one French and one Asian. The items which have been found significantly different (Mann-Withney U test) testify to cultural specificities. With the second method (Fischer's linear discriminant analysis) it can be concluded that there exists a certain homogeneity in the representation linked to the perception of attitudes and behavior of the pedestrian. The factors that can impact perception of the pedestrian are thus manifold, linked to cultural environments and practices but also to behavior that appears more universal.

Keywords
social representations and behavior, pedestrians, safety, characterization questionnaire, urban cultural environment, French and Asian cultures

Position of the Problem

The new stakes relating to walking as a healthy, environment-friendly means of mobility imply a new approach to the problem of mobility and pedestrian safety. Pedestrian safety is one of the highest stakes in terms of accidents (World Health Organization, 2013) and this approach falls within different environmental and cultural contexts if the case of France and Asia is taken (population, climate, infrastructures, etc.). In France, the implementation of the "street code" was launched on April 18, 2006, by the Minister of Transport. The purpose is to reinforce the safety of vulnerable users and tends to promote the use of non-motorized means. After the first Order 2008-754 of July 30, 2008, the Order 2010-1390 of Nov. 12, 2010, introduced new concrete advances concerning the principle of carefulness for pedestrian safety reinforcing the status of priority user for the latter. In Angers which is an average-sized French town, the tramway appeared in 2011. The implementation of the "street use code" aims to incite people to use alternative means of transport (other than private transport), to make travelling safer and to share out public space. It is part of a currently on-going experiment that attaches great importance to the development of "30-zones" allowing the road to be shared safely and peacefully. "30-zones" are zones identified by speed-limit signs and ground markings to remind motorized vehicle users of the importance of respecting the speed limit to protect non-motorized users.

Singapore, a land-scarce country, with one of the highest population densities in cities, has adopted several strategies to manage spatial competition. In an environment where the railway

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system is growing, the problem of non-motorized transport (NMT) in particular walking and cycling represents a "healthy and environmentally-friendly alternative mode of transport" (Koh, Wong, Chandrasekar & Ho, 2011; Koh & Wong, 2012a, 2012b). Recently, there has been a surge in cycling interest in Singapore (Koh & Wong, 2012d). This has led to some pedestrian-cyclist conflicts as many cyclists choose to cycle on the footpaths and pedestrian crossings though it is illegal. This could be due to many contributing factors including the availability of a comprehensive pedestrian network (paved sidewalks are present along almost all roadways), the provision of off-road cycling tracks and residential culture and customs. Another significant factor important to pedestrians is the provision of shelter, due to the hot and humid weather of Singapore (Koh & Wong, 2012c).

Currently, sheltered walkways are provided in the vicinity of major transport nodes. In line with France's Street code, "pedestrianalization" or creating more pedestrian spaces/streets are not new in Singapore. In fact, it started as early as 1972 at Raffles Place (Yuen & Chin, 1998). The original car parking space was replaced with a pedestrian boulevard in-between commercial buildings. Other examples include permanent conversions like Change Alley (an air-conditioned pedestrian bridge with shops), Bugis Junction (a covered air-conditioned pedestrian shopping street), Little India Arcade, Clarke Quay/Boat Quay, Waterloo Street and Albert Street, as well as part-time conversion such as Boon Tat Street (vehicular street closed during evenings for trolley food stalls) (URA, 1998). All these pedestrian streets have the common characteristics of a lot of people, situated in the central area of Singapore, as a preservation of local culture and often linked to a commercial component.

If we look at pedestrians' daily life in these two cultural environments, an already long-established history of pedestrianalization in Singapore is contrasted with a recent history in France. Concerning legislation about pedestrians, in Singapore, pedestrians are prohibited from crossing within 50m of a designated crossing (both directions) (AGC, Singapore). In France since 2010, pedestrians are considered to have priority everywhere if they show their intention of crossing but even so, they must use the pedestrian crossing if there is one within 50m. In a perspective of comparative study, reference must also be made to the cultural differences between the East and the West. Hall's works (1966) thus demonstrate management of space that differs in these cultures. Hofstede's works (1987) differentiate these cultures on several dimensions. Unlike France, which belongs to an individualistic culture, the notion of group is more important in Singapore, which represents a collectivist culture. The second important distinction concerns "the control of uncertainty". Some societies condition their members to accept uncertainty and "their members have a natural tendency to feel relatively secure" (Hofstede, 1987, p. 14; our translation). These societies are said to have "weak control of uncertainty", which is the case in Singapore. On the other hand, France belongs to the societies with strong control of uncertainty "whose institutions seek to create security and avoid risks" (p. 14; our translation).

In this case the populations have a greater level of anxiety with more emotionalism and aggressiveness. Other works show that these two cultures are differentiated by walking speeds. In a study of 32 countries, Singapore is considered to have the "world's fastest walkers" (British Council, 2007). Statistically, concerning pedestrian accidents, children and elderly people remain the most vulnerable users and in Singapore, the majority of deaths among the elderly are due to the problem of jaywalking (http://news.asiaone.com/News/AsiaOne+News/Singapore/Story/A1Story20110128-260741.html). Depending on the evolution of societies but also their density, certain situations of risk for pedestrians are still not priorities for study in France. For example the danger of using the telephone is above all presented for motorists but is much less dealt with as a factor of risk for pedestrians as is the case in other countries (Hatfield & Murphy, 2007; Nasar, Hecht & Wener, 2008; Nasar & Troyer, 2013)

Research on Social Representation of the Pedestrian

The problem of relations between road users and in particular between pedestrians and drivers starting from a representational approach has given rise to several publications. In order to understand this research it is necessary to define the theoretical field of social representations. The concept of social representation first appeared in a study by Moscovici in 1961 in which he showed how an object "psychoanalysis" was assimilated by French society in the 1950's. This representation was only partially built from objective data but it was irrefutable knowledge since it was shared by individuals. Reference was thus made to a socio-cognitive approach in which "cognitive formations" were produced socially. Moscovici (1961/76) defined social representation as "a modality of particular knowledge whose function is the elaboration of behavior and communication between individuals" (our translation; p. 26).

These first works gave birth to several schools of research notably that of the structural approach of the central core (Abric, 1976; Flament, 1987). The theoreticians of this approach started from the concept of figurative core proposed by Moscovici and substituted it by that of "central core." In this model, representation is organized around a consensual and non-negotiable central core and a conditional periphery linked to individual practices. However, as all objects are not objects of social representation, Flament and Rouquette (2003) insist on the two minimal clauses of their existence. On one hand, sociocognitive salience (namely because the object is approached recurrently in communications) and on the other hand the practices toward the object of the population studied. Practices are effectively inseparable from representations although certain research shows that cultural membership goes beyond practices.

For example, Gaymard (2003) compared the social representation of higher education among young students of Maghrebian origin and young women of the same origin not in higher education. The author showed that this representation was homogeneous in spite of different practices, and that it belonged to the bicultural specificity of the groups. This is linked to the stakes concerning women's condition in their original culture and the stakes concerning the social condition of their parents coming from a humble background. The analysis of social representations relies on the verbatim of the subjects and different tools may be used. This methodological diversity can be found in studies dealing with social representation of the pedestrian. Gaymard, Boucher, Greffier and Fournela (2012) used the free association test with the inductor "pedestrian" among drivers, and showed that social representation was linked to infrastructures (pedestrian crossings, footpaths) and the means of mobility (walking). By using specific instructions which require the drivers to answer by putting themselves in the place of another group, they revealed the conflictual relationship between drivers and pedestrians (the drivers express criticism of the pedestrians). Gaymard & Andrés (2013) asked students to answer to the dual inductor "cyclists and pedestrians." The representation, which is articulated around the elements Highway Code and sharing is given concrete expression at the level of the periphery with the notion of danger, the most frequently quoted word. In another study, Gaymard, Andrés & Nzobounsana (2011) used a characterization questionnaire composed of 20 items from which French and Spanish drivers had to choose the most and the least characteristic of the object (here the pedestrian). In this exploratory study, the authors showed that independently of the cultural origin, all the drivers attribute an undisciplined and unpredictable character to pedestrians.

With the little story technique, Gaymard (2012) puts the driver in a situation with pedestrians while varying the environments and the latters' attitudes. The respondents are thus placed in the driver's situation and must complete the stories proposed. The analysis of multiple correspondences brings to light different feelings expressed by the driver toward the pedestrian. For example, in an urban context, s/he appears aggressive when the pedestrian's attitudes are perceived to be disrespectful or when pedestrians do not respect the infrastructures dedicated to them. Inversely, the driver expresses positive feelings when the pedestrian is described as courteous, thus showing the importance of civil attitudes in situations of interaction.

The cultural comparison between France and Spain with the same tool (Gaymard, Andrés & Nzobounsana, 2011) shows homogeneity in the feelings expressed according to the driving contexts and the pedestrian's attitudes. Using models from the cognitive neurosciences and social cognition, Gaymard, Boucher, Nzobounsana, Greffier and Fournela (2013) demonstrate that there exist correlations between visual salience measures and the verbatim of drivers viewing the road scenes. What is physically seen is correlated with the drivers' verbatim thus proving the complementarity of the visual and psychosocial variables. In this study, they show the impact of the environment and the pedestrian's attitudes in the way of reacting to the driver: "An environment that integrates a significant number of road objects (vehicle, pedestrians, road signs) is correlated to the negative feelings linked to the perception of a feeling of insecurity and dangerousness . . . [the driver] may thus have a feeling of security when the environment is clear, when the pedestrian is on the crossing, and when he or she is courteous " (our translation; Gaymard, et al., 2013).

Finally in the field of social representations and norms, several studies based on the conditionality theory have shown the importance of legitimate transgressions in the drivers' representation (Gaymard, 2007, 2009, 2013). Gaymard and Tiplica (2012) used the Conditional Script Questionnaire (CSQ) adapted to the pedestrian. With this tool they highlight in which circumstances the pedestrian was more or less respected and propose risk modeling via the use of Bayesian Networks. The advantage of these different tools is to enable the study of the interactions between drivers and pedestrians because these interactions are not taken into account in most simulation models (Tom, Auberlet & Bremond, 2008).

The question of impact of the environment or culture on perception is important but there exist few comparative works on this topic. Gaymard, Andrés & Nzobounsana (2011) compared the social representations of young French and Spanish drivers toward pedestrians. They also studied drivers' emotions in a situation of interaction with pedestrians. The results show that the Spanish prove to be more sensitive to pedestrian vulnerability. For Andrés & Gaymard (2010), who are concerned with the cultural construction of representations, the differences of representations can be attributed to cultural specificities. Young Spanish drivers appear to be more charitable toward pedestrians, notably elderly pedestrians since the Spanish family model is centered more on support and solidarity toward the elderly. It can be seen that the question of social representations is inseparable from the cultural environment and only comparative approaches can highlight this. In this study, working from two very different environments, the following hypotheses are formulated:

•H1: The latest advances in legislation for the pedestrian in France lead us to hypothesize that the character of priority of the latter will be more salient in young French people's representation.

•H2 : It is supposed that the characterization of the pedestrian in Singapore will be associated more with the use of the telephone.

•H3 : It is supposed that the individualism/collectivism dimension will differentiate the characterization of the pedestrian.

•H4 : The hypothesis is made that there exists a difference in the perception of the pedestrian's speed.

•H5 : It is supposed that certain characteristics such as "unpredictable" and "cross anywhere" will be shared by the two groups.

•H6: It is supposed that for both cultures, sharing space with cyclists is not chosen as characteristic of the pedestrian.

Method

The Characterization Questionnaire

To study the social representation of the pedestrian, we used a tool specifically developed in this framework (Flament & Rouquette, 2003; Gaymard, 2002; 2003). We start from the characterization questionnaire proposed by Gaymard, Andrés & Nzobounsana (2011) which was slightly modified in order to suit both countries studied. Thus in the initial version "share space" was replaced by "can share space with cyclists"; "pedestrian crossing" by "disregard zebra crossing,"; "cross slowly on purpose" by "talking on phone/messaging" (Table 1).

Working from a questionnaire comprised of 20 items (in order to allow choices by sets of 4 items), the subjects are asked first of all to choose the 4 items most characteristic of the object studied (here the pedestrian). This choice is compulsory: four items are required and not three or five. Then, they are asked to choose the 4 items least characteristic of the object studied from the remaining items. After this, they must choose the 4 items which are still slightly characteristic and finally the 4 slightly less characteristic.

Each item is then coded from 1 to 5: 5 if chosen as characteristic (+2); 1 if chosen as non characteristic (-2); 4 if chosen as still slightly characteristic (+1); 2 if chosen as slightly less characteristic; and 3 if not chosen by the subject questioned. Consequently this questionnaire is of a "rectangular Q-sort" type. This differs from the classical Q-sort which attempts to approach a Gaussian Law. The items with a distribution whose mode is in the central class do not concern us here but on the contrary those with a very unsymmetrical distribution giving priority to the dimension of "characteristic" or "non characteristic" (Vergès, 2001). According to the central core theory, a highly characteristic item can be considered to be a possible central element (Flament & Rouquette, 2003; Gaymard, 2003).

The questionnaire was put on line so that the students of both universities (Angers and Singapore) of both countries (France and Asia) wishing to take part in the study could fill it out; as the study was based on voluntary participation, we could not control the variable of gender.

Table 1. Items Constituting the Characterization Questionnaire

Careful	Don't respect the green light (for the drivers)
Have time	Unpredictable
Fragile	Children
Cross anywhere	Wait
In a hurry	Dangerous
Teenagers	Can share space with cyclists
Disregarded on zebra crossings	Elderly people
Have priority	Impose themselves
Courteous	Talking on phone/messaging
Respectful	Pedestrians in group

Population

After clearing the data file and checking the answers, we were able to retain for the analysis, 77 students from Angers (Angevins) 14 male and 63 female and 115 students from Singapore (Singaporeans) 60 male and 55 female. The average age for the French students is 20.14 (*SD* = 2.24), the average age for the Asian students is 22.10 (*SD* = 2.72). We worked on the totality of the groups without taking into account the gender variable.

Analysis Strategies

After transforming the data from 1 (-2) to 5 (+2) (Gaymard, 2003), we used the Mann-Withney U test to highlight the differences in ranking. For samples greater than 20, the sampling distribution of the U statistics tends to a normal distribution (Siegel, 1956) and, as a result, the U statistics are accompanied by a z value (value of the standard distribution) and its respective p value. We also carried out a Fischer linear discriminant analysis and a quadratic discriminant analysis in order to assess the separability of the two student classes (the Angevins and the Singaporeans) on the basis of the answers given to the 20 items previously mentioned. The most discriminating variables were kept using an ascending step by step selection procedure (more precisely, at each step, all the variables are examined and those that contribute most towards discriminating the groups are introduced in the model).

To obtain a more realistic estimation of the efficiency of discriminant analysis as a supervised classification tool, one has to evaluate the generalization ability and the robustness of this classifier. The generalization ability of the classifier is evaluated by the cross-validation test and represents the ability of the classifier to correctly classify observations that have not participated in the construction of the discriminant functions. The "leave one out" technique is very effective and often used in cross-validation of different classifiers. The principle of this technique is to leave out one observation for the test and to use the remaining observations for the construction of the discriminant functions. This operation is repeated for each observation present in the data set and then, the mean of the different classification errors is calculated. In this way, a very good estimation of the real classification error rate of the classifier is obtained. The robustness of a classifier is related to the number of descriptors included in the model. It is well known that keeping non-informative descriptors in the model increases the classification error rate of new observations. The final goal when using a classifier is to obtain the lowest classification error of observations which did not participate in the construction of discriminant functions with the smallest number of descriptors.

Results

The Mann-Withney U test.

Table 2 (p. 265) shows the results of the Mann-Withney U test. As can be seen, for the following items : "fragile", "in a hurry", "elderly", "have priority" and "talking on phone/messaging", there is a significant difference between the answers given by the French and Asian students. Figure 1 (p. 266) shows these differences in the distribution (the 95% confidence interval is also given). Thus it can be seen that on average, the French students consider the items "fragile" and "have priority" as more characteristic of the pedestrian than their Asian counterparts. Inversely, the Asian students consider the items "elderly," "in a hurry" and "talking on phone/messaging" as more characteristic of the pedestrian than their French counterparts.

Figure 2 (p. 267) illustrates the histogram of answers made for the different items. It can be seen that 35 % of the Angevins chose modality 5 (the most characteristic) for the item "fragile," compared with only 17% of the Singaporeans; whereas the tendency is completely inverted for modality 1 (the least characteristic) (9% of the Angevins compared with 23% of the

Table 2. Results of the Mann-Withney U Test

	Sum of Rangs Singapore	Sum of Rangs Angers	U	Z	p value	Adjusted Z	p value
Careful	11308,5	7219,5	4216,5	0,5578	0,5770	0,5784	0,5630
Don't respect	11362,5	7165,5	4162,5	0,7009	0,4834	0,7163	0,4738
Have time	10540,0	7988,0	3870,0	-1,4760	0,1400	-1,5222	0,1280
Unpredictable	10730,0	7798,0	4060,0	-0,9725	0,3308	-1,0027	0,3160
Fragile	9793,0	8735,0	3123,0	-3,4554	0,0005	-3,5299	0,0004
Children	11001,5	7526,5	4331,5	-0,2531	0,8002	-0,2608	0,7942
Cross anywhere	11285,5	7242,5	4239,5	0,4968	0,6193	0,5270	0,5982
Wait	11463,0	7065,0	4062,0	0,9672	0,3335	0,9895	0,3224
In a hurry	12497,5	6030,5	3027,5	3,7084	0,0002	3,7903	0,0002
Dangerous	10966,0	7562,0	4296,0	-0,3471	0,7285	-0,3552	0,7224
Teenagers	11703,5	6824,5	3821,5	1,6045	0,1086	1,6814	0,0927
Can share space	10942,5	7585,5	4272,5	-0,4094	0,6822	-0,4201	0,6744
Disregard zebra	11116,5	7411,5	4408,5	0,0490	0,9609	0,0501	0,9600
Elderly	11838,5	6689,5	3686,5	1,9622	0,0497	2,0172	0,0437
Have priority	9736,0	8792,0	3066,0	-3,6064	0,0003	-3,7145	0,0002
Impose themselves	10708,5	7819,5	4038,5	-1,0295	0,3033	-1,0608	0,2888
Courteous	11619,5	6908,5	3905,5	1,3819	0,1670	1,4312	0,1524
Talking on phone	12063,5	6464,5	3461,5	2,5584	0,0105	2,6422	0,0082
Respectful	11021,0	7507,0	4351,0	-0,2014	0,8404	-0,2074	0,8357
Pedestrians in group	11629,5	6898,5	3895,5	1,4084	0,1590	1,4401	0,1498

Singaporeans) concerning the same item. This clearly illustrates a completely different point of view concerning the perception of the pedestrian's fragility according to the students' nationality. In the same way, for the item "have priority" it can be seen that 44% of the Angevins chose this item as the most characteristic (modality 5) compared with 25% of the Singaporeans. Inversely for the same item, 8% of the Angevins chose it as being the least characteristic (modality 1) compared with 23% of the Singaporeans.

Now if we take the items that are significantly more characteristic for the Singaporeans, it can be seen that 19% chose the item "elderly" as the most characteristc compared with 9% of the Angevins. Concerning the item "in a hurry," 31% of the Singaporeans considered it to be very characteristic of pedestrians compared with 6% of the Angevins. For the same item 17% of the Singaporeans chose it as the least characteristic compared with 30% of the Angevins. Finally, concerning the item "talking on phone/messaging," 33% of the Singaporeans considered it to be very characteristic of the pedestrian compared with 21% of the Angevins.

Concerning the other items which do not significantly differentiate the groups (see histograms in Appendix), it can be seen that the items "can share space with the cyclists," "courteous," "respectful" and "wait" are not considered to be characteristic of the pedestrian (they are chosen as "non characteristic"). Thus a consensus can be observed for these items in both countries when characterizing the pedestrian. It is considered that the pedestrian can not share the space with cyclists; that the pedestrian is not courteous; that the pedestrian is not respectful; and that the pedestrian does not wait. On the other hand, the items "careful," "cross anywhere" and "unpredictable" are characteristic of the pedestrian and there also exists homogeneity between the two countries here. It is considered that carefulness is associated with the pedestrian; that the pedestrian crosses anywhere; and that the pedestrian is unpredictable.

Even if the differences are not significant, cultural particularities can be observed in the distribution of the answers. For example, for the Asian students "the pedestrian in a group" is more characteristic (46% of choices 4 and 5) than for the French students (34% of choices 4 and 5). Similarly for the French students, the item "impose themselves" is more characteristic of the pedestrian (34% of choices 4 and 5) than for the Asian students (12% of choices 4 and 5).

Fischer's Linear Discriminant Analysis & Quadratic Discriminant Analysis

The step by step selection procedure is guided by the statistical significance of a variable in discriminating classes, that is, it is a measure of the degree to which a variable solely contributes to forecast group membership.

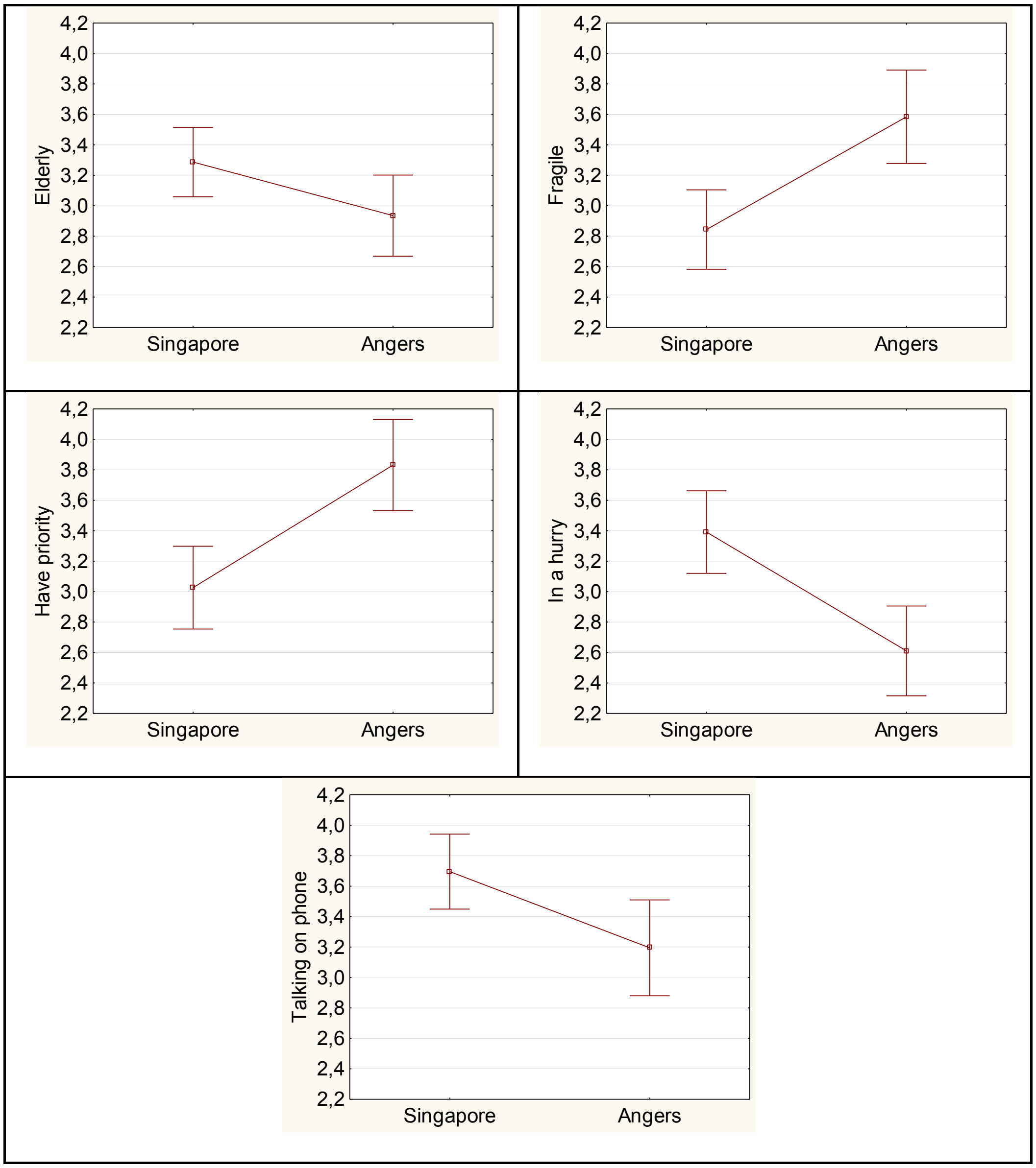
The items presented in Table 3 (p. 269) were found to be the most significant for group discrimination. It can be seen that the most discriminant variables are (in descending order): "in a hurry," "have priority," "elderly," "talking on phone," "courteous," "wait" and "pedestrians in group." Compared to the previously discussed analysis of ranks, we see that there are several common variables ("in a hurry," "have priority," "elderly," "talking on phone"), but also variables such as the new items "courteous," "wait" and "pedestrians in group."

Using the seven variables listed in Table 3 (the most significant for the discrimination of the two nationalities), we obtained the classification matrix shown in Table 4 (p. 269). These results were obtained using the "leave one out" cross-validation method. In the framework of this validation method, one observation is used for the remaining observations serving to calculate the factorial axes. One can also note that the total percentage of well classified observations is 65.10% when using the 20 items of the original questionnaire (Table 5, p. 269).

It is clear that the seven variables used in Table 3 are relevant because adding the 13 remaining variables improves the classification accuracy by just 0.52%.

Classification matrices obtained using quadratic discriminant

Figure 1. Average Difference Between the French & Asian Students for the Items Identified as Significant by the Mann-Withney U test (see Table 1)



analysis with the seven variables used in Table 3 and all 20 items are presented in Tables 6 and 7 (p. 269).

One can see that quadratic discriminant analysis has the smallest classification error rate (see Table 6) provided that the items used for analysis are chosen carefully. Nevertheless, one can observe that the discrimination of the two populations of students is quite difficult (68.75% of well classified observations in the best case).

Discussion

The problem of accidents involving pedestrians in the urban environment is not new and it arouses great interest globally on different levels of expertise (e.g., Aziz, Ukkusuri & Hasan, 2012; Arregui-Dalmases, Lopez-Valdes & Segui-Gomez, 2010; Damsere-Derry, Ebel, Mock, Afukaar & Donkor, 2010; Gitelman, Balasha, Carmel, Hendel & Pesahov, 2012; Kanchan, Kulkarni, Bakkannavar, Kumar & Unnikrishnan, 2012; Martin, et al., 2010; Otte, Jänsch & Haasper, 2012; Peng, Chen, Yang, Otte & Willinger, 2012; Shinar, 2012; Thoma, 2012; Vernez Moudon, Lin, Jiao, Hurvitz & Reeves, 2011). According to WHO (2013), "Based on estimated global road traffic fatalities, about 273,000 pedestrians were killed in road traffic crashes in 2010. This represents around 22% of all road traffic deaths" (p.9); pedestrian injuries and fatalities involve several costs such as psychological, socio-economical and health. In the case of the U.S., for instance, in 2012, there were 4,743 pedestrian fatalities and 76,000 injuries (estimation) in traffic crashes, which is a rise of 6% compared with 2011 (NHTSA Traffic Safety Facts). Pedestrian injuries involving children aged 14 and under cost a total of $5.2 billion per year (Miller, et al., 2004).

In this study we were concerned with the social representation of the pedestrian in relation to the cultural environment by comparing two very different cities both in size and in their history of pedestrianalization. Social representations are defined as groups of beliefs, opinions and attitudes toward a given object and linked to social practices (Gaymard, 2000). The interest of studying social representations lies in the influence that they have on behavior (the reverse is also true); understanding them better thus helps to implement new measures that take into account the social thinking of individuals associated to their daily practices.

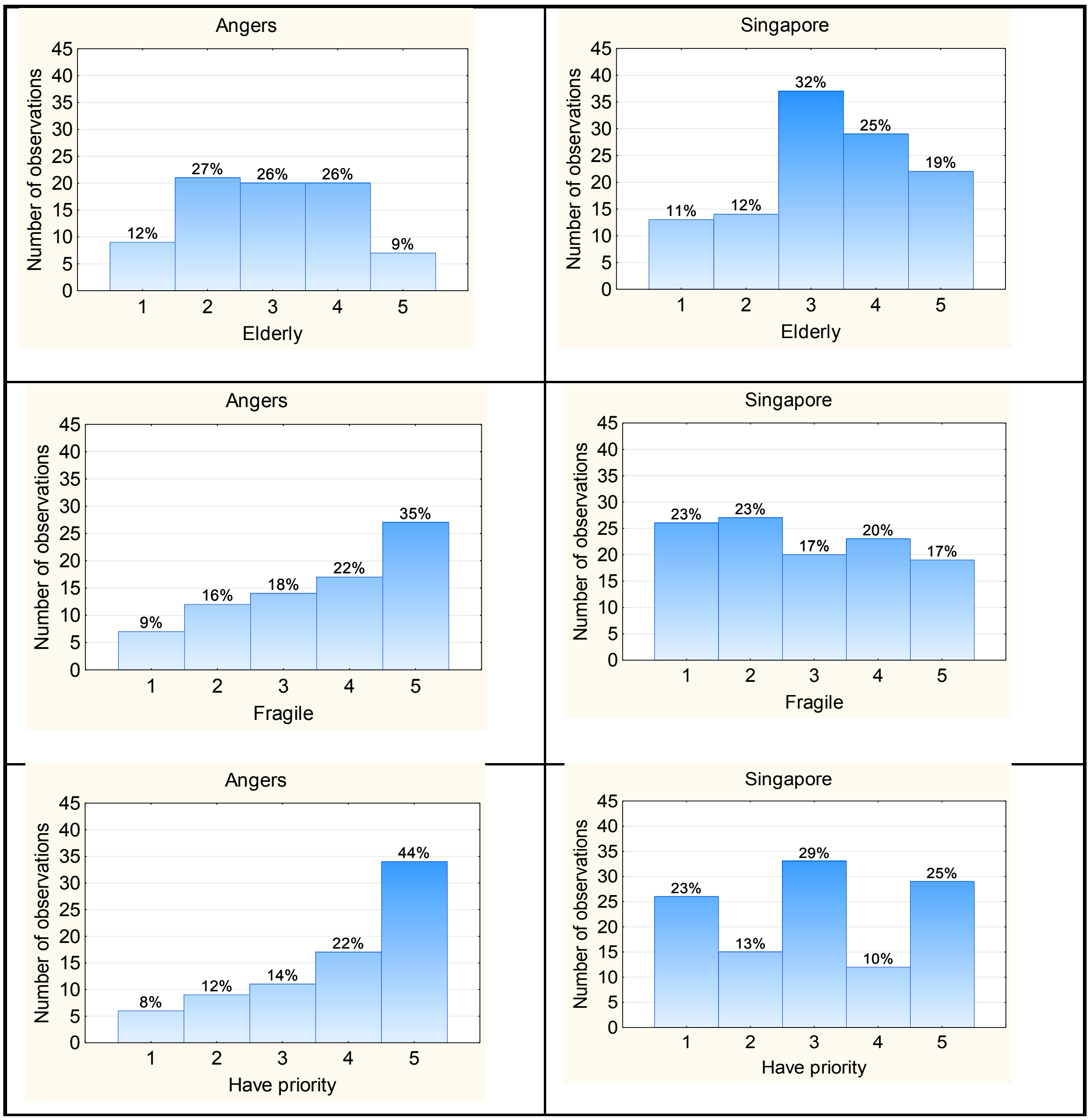
Several hypotheses have been put forward concerning cultural differences or characteristics shared by both cultures. The hypotheses are largely confirmed. The first four dealt with a difference in representation taking into account the environmental and cultural particularity of each city and the history of pedestrianalization. Singapore is one of the biggest cities in terms of population density and the implementation of the street use code dates back several decades. On the other hand, Angers is a medium-size city and the "street use code" measure in France is relatively recent since it dates back to 2006 with a new order in 2010 that develops the pedestrian's status of priority. The results from the Mann-Withney U test highlight a significant difference between the answers given by the French and Asian students for the following items: fragile, in a hurry (Hypothesis 4), elderly, have priority (Hypothesis 1) and talking on phone/messaging (Hypothesis 2). If the French students consider the items "fragile" and "have priority" as more characteristic of the pedestrian than their Asian counterparts, the reverse is observed for the Asian students concerning the items "elderly," "in a hurry" and "talking on phone/messaging" which they consider to be more characteristic than their French counterparts. The characterization of the French pedestrian with the items "fragile" and "have priority" is very homogeneous as histograms with a "J curve" typical of the central elements of the representation can be observed (Flament & Rouquette, 2003; Gaymard, 2003). This can be interpreted as an evolution in mentalities following a change in the Highway Code. In France since the Order of Nov. 12, 2010, pedestrians are effectively considered to have priority everywhere "as soon as they step out or clearly show the intention of stepping out on to the road, the driver must let them pass." These results with the item "fragile" thus go toward change in representation already mentioned by Gaymard, Boucher, Nzobounsana, Greffier and Fournela (2013).

Data gathered from Angers students before this new order testify to this evolution. With a free associations test and the inductor "pedestrian," Gaymard, Boucher, Greffier and Fournela (2012) thus highlighted that the highest frequencies concerned infrastructures and environmental practices (walking). This study was exploratory but the authors had suggested that priority and vulnerability would be more peripheral in the representation, that is, linked to individual and conditional practices.

With the results observed here it can be said that there is more recognition of the question of pedestrian priority. Similarly in the study of Gaymard, Andrés and Nzobounsana (2011) in which the data was collected before 2010, the pedestrian's fragility appeared less characteristic in the French students' discourse compared with the present study. The development of 30 zones in the urban landscape and the latest advances in legislation to protect pedestrians go toward a change in mentalities.

In Singapore the history of pedestrianalization is older and priority is given to the pedestrian in very precise cases, which explains that this item is less characteristic: At zebra crossings: vehicles have to give way to pedestrians; -at signalised pedestrian crossings: the green man phase is given to pedestrians, however, right-turning and left-turning vehicles have to give way to pedestrians during the same phase. In the same way, the fact that Singaporeans characterize pedestrians more with the items " in a hurry" and "talking on phone/messaging" can be explained by cultural characteristics. This is not surprising as Singapore is rated the fastest-moving city in the world (Wong, 2007). With this fast pace of life, people are often seen multi-tasking even when walking. Along with the hypotheses put forward, the item "elderly" is significantly more characteristic of the pedestrian in Singapore. As the Singapore population is growing very fast into an ageing population, there seems to be more concern in this elderly group. This difference in representation constitutes an asset considering the involvement of this group in accidents (Singapore Police Force, 2011). Compared

Figure 2. Histograms for Answers Given by the Angers & Singapore Students to the 5 Significantly Different Items According to the Mann-Withney U Test (see Table 1)



with France where elderly pedestrians are also particularly exposed, these results testify to increased communication concerning elderly pedestrians in Singapore.

In addition to cultural specificities, the attribution of similar characteristics can be seen for both groups, which validates hypotheses 5 and 6. The histograms effectively show that pedestrians are seen in the same way by the Angevins and the Singaporeans who attribute the following characteristics to them: “cross anywhere “ and “unpredictable “ (Hypothesis 5). In the study of Gaymard, Andrés & Nzobounsana (2011), the items “unpredictable” and “cross anywhere” belonged to the items most characteristic of the pedestrian for French students and Spanish students. These items linked to the problem of anticipation toward pedestrians and to their behavior seen as undisciplined and illegitimate thus appear very stable in the representation.

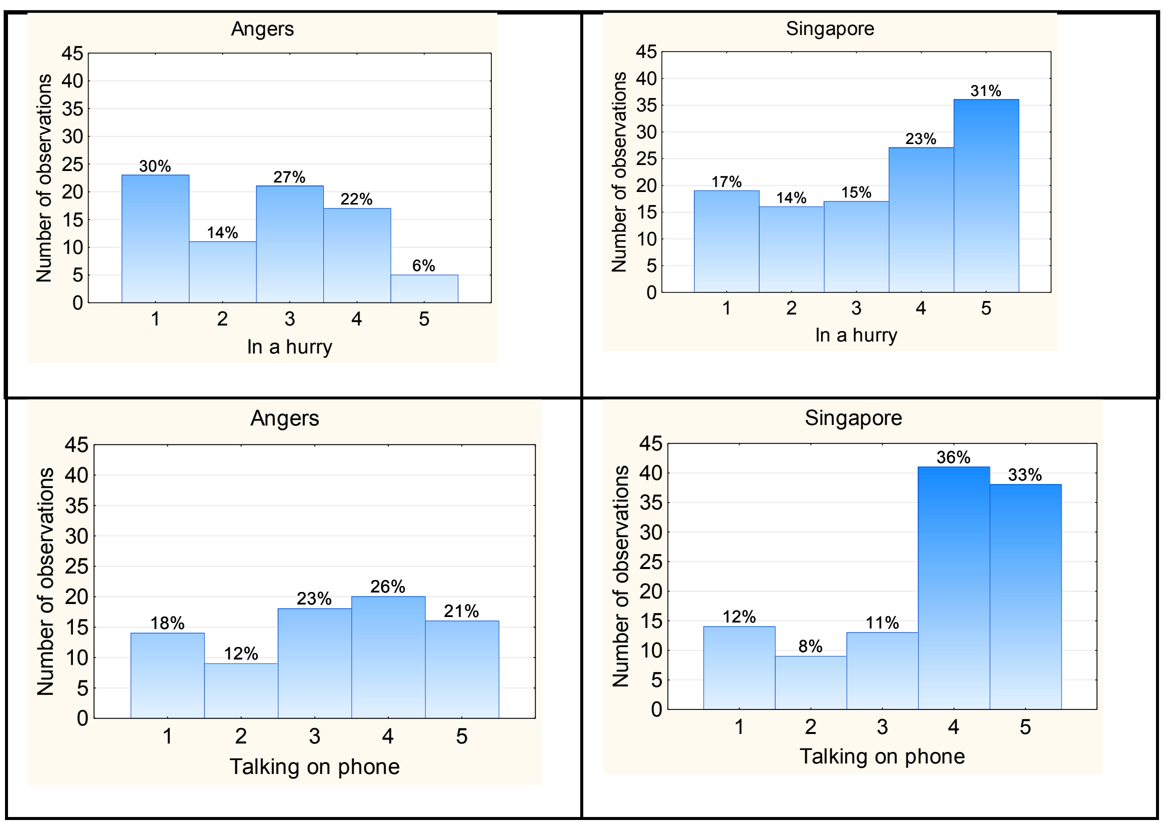
These results join other studies that refer to “illegal pedestrian behavior” and (or) remind us how this behavior is involved in accidents (Keegan & O’Mahony, 2003; Kim, Brunner & Yamashita, 2008; King, Soole & Ghafourian, 2009; Lange, Haiduk, Schwarze & Eggert, 2011; Teanby, Gorman & Boot, 1993; Ulfarsson, Kim & Booth, 2010). But the problem with pedestrians is also linked to an ignorance of priority rules (Herbert Martinez & Porter, 2004; King, Soole & Ghafourian, 2009; Sarkar & Andreas, 2004). The study by Gaymard, Boucher, Nzobounsana, Greffier and Fournela (2013) which relies both on visual salience measures from road scenes recorded with an electronic eye and on psychosocial measures, shows that pedestrians are visually salient and present in the discourse when they are in pedestrian environments that render them legitimate and make recognition of them easier.

Moreover for both groups, Angevins and Singaporeans, several items are chosen rather as non-characteristic of the pedestrian. Both Angevins and Singaporeans think that the pedestrian cannot share space with cyclists (Hypothesis 6), which reflects problems of space sharing between the two types of users. The development of friendly modes of mobility results in reduction of space for vehicles and a problem of territory sharing which requires adapted infrastructures (Hamilton-Baillie, 2008; Kaparias, Bell, Miri, Chan & Mount, 2012). With the development of walking and cycling, interactions between pedestrians and cyclists have multiplied and it can be supposed that the likelihood of collisions has also increased because they often share the same infrastructures (Chong, Poulos, Olivier, Watson & Grzebieta, 2010; Graw & König, 2002). The problem of speed between cars and pedestrians (Rosén, Stigson & Sander, 2011; Tefft, 2012) is now found between bicycles and pedestrians and even if the consequences are less serious, it must be taken into account. Furthermore, like pedestrians, cyclists adopt illegal behavior such as red light infringement (Johnson, Charlton, Oxley & Newstead, 2012). There is also a problem of territorial management between vulnerable users who do not respect infrastructures, whether traffic lights or environments (this is typically the case of shared sidewalks where one part should be reserved for cyclists and the other for pedestrians).

But despite the impact of infrastructures or the environment (Cho, Rodríguez & Khattak, 2009), there is another problem concerning the perception of disrespect which increases relations of conflict between users. Angevins and Singaporeans also agree there considering that the pedestrian is not courteous nor respectful. This confirms the works of Gaymard, Boucher, Nzobounsana, Greffier and Fournela (2013), which refer to a multidimensional construct including multiple variables such as vision, social representations and feelings according to the driving contexts.

Previous studies on social representation of the pedestrian show that these attitudes of civility are perceived to be inexistent whereas they are important in situations of interaction favoring the expression of positive feelings in the driver who finds it legitimate to respect the pedestrian in this case (Gaymard, Boucher, Nzobounsana, Greffier & Fournela, 2013). The study of Gaymard and Tiplica (2012) testifies that respect of pedestrians is not conditional when they are courteous; this is one of the rare conditions along with

Figure 2 (continued)



respect of infrastructures that renders them legitimate in drivers' eyes. Gaymard (2012) used the little story method to analyze people's discourse in contextualized environments. The other advantage to this method is that it reveals the emotional component of the representations. The author shows that when the driver interacts with a pedestrian who is described as courteous, s/he has positive feelings. On the contrary, a pedestrian described as disrespectful accentuates the driver's aggressiveness.

The use of Fischer's linear discriminant analysis and quadratic discriminant analysis makes it possible to reveal certain items which appeared significant with the Mann-Withney U test: "in a hurry," "have priority"elderly" and "talking on phone/messaging." Other items which were not significant help in a more modest way to differentiate the two groups; these are the items "courteous," "wait" and "pedestrians in group." When we look at the histograms (see Appendix, pp. 272-273), it can be seen that the items "courteous" and "pedestrians in group" are a little less characteristic for the Angevins and that the item "wait" is a little more characteristic for this population. The hypothesis of a difference in the individualism/collectivism dimension was put forward (Hypothesis 3) and we believe that the most important characterization of the item "pedestrians in group" works toward this hypothesis. In Singapore people often go out in a group of family and friends, including grown-up children. (Wong, personal communication). This collectivist dimension can also be linked to the management of space or "proxemy," Hall's works (1966) having shown the importance of being together and in a close in Asian cultures. Moreover the differences between the two cultures concerning the control of uncertainty (Hofstede, 1987) can explain why there is more emotionalism and aggressiveness in relations between French users. Effectively they appear more sensitive to a lack of courtesy and they more often find that pedestrians impose themselves. Finally, the item "wait," which is less characteristic among Singaporeans, confirms the perception of walkers "in a hurry " in this cultural context.

Despite everything, the discrimination between the two populations of students remains quite difficult (68.75% of observations well classified in the best case). This can be interpreted by a perceived homogeneity of the pedestrian that can be explained by the age group of both populations. Studies with a certain number based on oculometric data attest to particularities in perception which are linked to age (Borowsky, Oron-Gilad, Meir & Parmet, 2012; Bromberg, Oron-Gilad, Ronen, Borowsky & Parmet, 2012; Evans & Macdonald, 2002).

In this study there are several limitations that should be underlined. First, the choice of place of the study (Angers vs Singapore) was directed by the fact that the research teams were already known to each other; hence we did not seek to compare two cities of strictly identical size. Second, the data collection on line based on voluntary participation did not allow the researchers to control

Table 3. The Most Significant Items for Group Discrimination

	Wilk (lambda)	Partiel (lambda)	F exclusion (1.184)	p value	Tolerance	1-Tolerance (R^2)
Wait	0,7984	0,9752	4,6798	0,0318	0,9068	0,0932
In a hurry	0,8354	0,9321	13,4109	0,0003	0,8974	0,1026
Have priority	0,8169	0,9531	9,0561	0,0030	0,9708	0,0292
Elderly	0,8124	0,9584	7,9780	0,0053	0,9396	0,0604
Courteous	0,8000	0,9733	5,0495	0,0258	0,9300	0,0700
Talking on phone	0,8108	0,9603	7,6131	0,0064	0,9213	0,0787
Pedestrians in group	0,7967	0,9773	4,2647	0,0403	0,9465	0,0535

Table 4. Classification Matrix for Linear Discriminant Analysis Using the Variables in Table 3

			predicted	
		% correct	Singapore	Angers
observed	Singapore	66,96	77	38
	Angers	61,04	30	47
	Total	**64,58**		

Table 5. Classification Matrix for Linear Discriminant Analysis Obtained Using the 20-Items Questionnaire

			predicted	
		% correct	Singapore	Angers
observed	Singapore	67,83	78	37
	Angers	61,04	30	47
	Total	**65,10**		

Table 6. Classification Matrix for Quadratic Discriminant Analysis Obtained Using the "Leave One Out" Cross-Validation Method & 7 Items in Table 3

			predicted	
		% correct	Singapore	Angers
observed	Singapore	73,04	84	31
	Angers	62,34	29	48
	Total	**68,75**		

Table 7. Classification Matrix for Quadratic Discriminant Analysis Obtained Using the "Leave One Out" Cross-Validation Method & the 20-Items of the Questionnaire

			predicted	
		% correct	Singapore	Angers
observed	Singapore	72,17	83	32
	Angers	48,05	40	37
	Total	**62,50**		

the variable of gender; there is, therefore, an imbalance between the two groups and between the genders especially for the French group. The survey on line also had an impact on the size of the sample because we had to eliminate certain incomplete observations. Finally, the characterization questionnaire has its limits since it can not integrate all the dimensions of the object. However from the methodological point of view the necessity of block choices (usually done face to face) imposes the number of items, which must not be too high (20 being quite the maximum). Despite these different limits and considering the complexity of the object, the classification accuracy of 65.10% appears honorable.

Conclusion

In conclusion, if the cultural context has an impact on the social representation of the pedestrian linked to physical, behavioral and attitudinal characteristics, there is consensus in the representation of the latter in relation to illegal behavior and unsuitable attitudes. Similarly, pedestrians and cyclists are not considered to "get on well together." Thus in a perspective of developing non-motorized modes of mobility for environmental and health reasons (Hickman, Ashiru & Banister, 2010; Kerr, Rodriguez, Evenson & Aytur, 2012; Pikora, Giles-Corti, Bull, Jamrozik & Donovan, 2003), authorities must look into measures that would allow improvement of the pedestrian's image but also the cyclist's because this influences practices.

To improve this image questions must be asked about infrastructures and territory sharing (what types of infrastructures for what types of sharing; cycle paths with speed limits, bicycle with motorized vehicles and pedestrian alone or pedestrians and cyclists on the same territory), but also the populations must be educated in the shared respect of the rules (which do not concern only the motorists) to improve the lack of fairness perceived between the different users in their relationship to the rules. Each user must feel considered and respected by the other and the street use code must be perceived as a Highway Code. But other considerations must be taken into account, such as the structure of the family model within the culture (Andrés & Gaymard, 2010; Gaymard, Andrés & Nzobounsana, 2011) and its impact, for instance, on the representation of elderly pedestrians.

This study allows the confrontation of perceptions that individuals have of pedestrians in their daily life; it thus maps the relations between road users in different cultural contexts. ⭘

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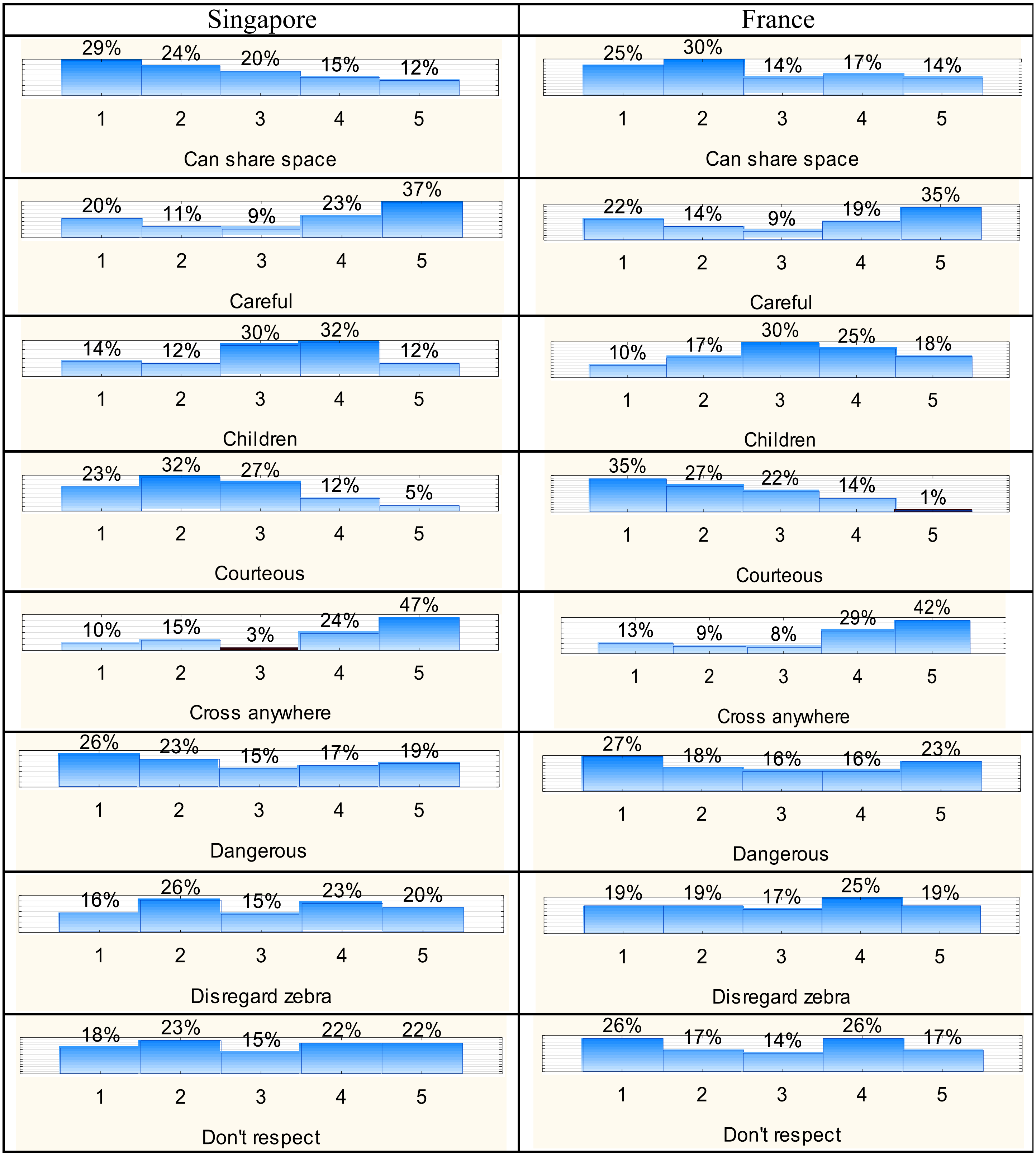
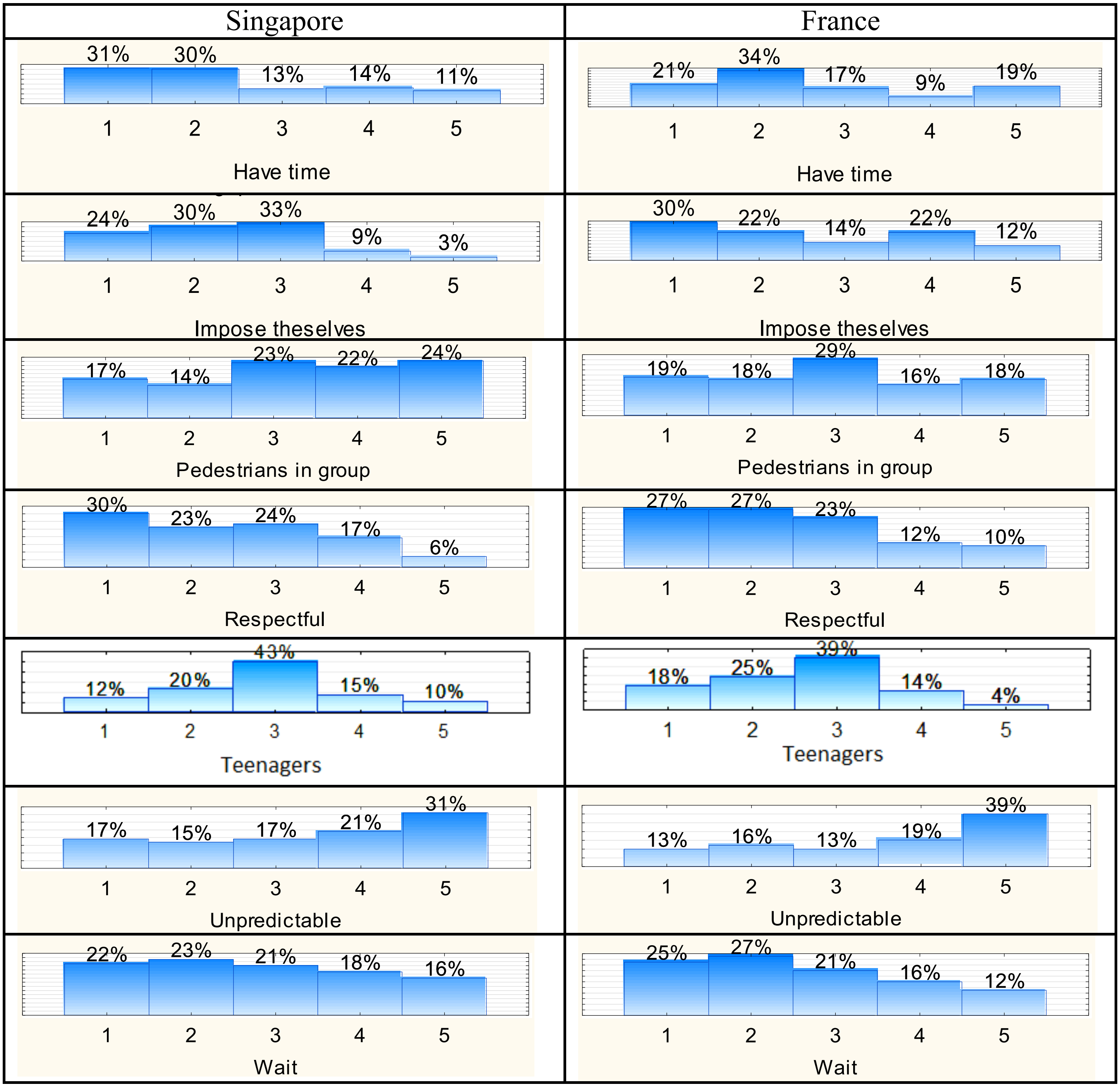
Appendix: Histograms of Items That Do Not Significantly Differentiate the Groups




Singapore
France
31% 30% 13% 14% 11%
1 2 3 4 5
Have time
21% 34% 17% 9% 19%
1 2 3 4 5
Have time
24% 30% 33% 9% 3%
1 2 3 4 5
Impose theselves
30% 22% 14% 22% 12%
1 2 3 4 5
Impose theselves
17% 14% 23% 22% 24%
1 2 3 4 5
Pedestrians in group
19% 18% 29% 16% 18%
1 2 3 4 5
Pedestrians in group
30% 23% 24% 17% 6%
1 2 3 4 5
Respectful
27% 27% 23% 12% 10%
1 2 3 4 5
Respectful
12% 20% 43% 15% 10%
1 2 3 4 5
Teenagers
18% 25% 39% 14% 4%
1 2 3 4 5
Teenagers
17% 15% 17% 21% 31%
1 2 3 4 5
Unpredictable
13% 16% 13% 19% 39%
1 2 3 4 5
Unpredictable
22% 23% 21% 18% 16%
1 2 3 4 5
Wait
25% 27% 21% 16% 12%
1 2 3 4 5
Wait