Investigating Industrial Investigators:

Examining the Impact of A Priori Knowledge and Tunnel Vision Education

by

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B.A., University of Victoria, 1999
M.Sc., Saint Mary's University, 2004

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ABSTRACT

Three studies addressed tunnel vision in industrial incident investigation. Study 1 surveyed professional investigators regarding how prior knowledge affects their investigative conclusions. Studies 2 and 3 experimentally explored the true impact of a priori information on investigative behaviour as well as the effectiveness of a debiasing intervention. Findings from Study 1 demonstrate that investigators typically know the people, position and equipment involved in the industrial event and they perceive this information as largely beneficial in their investigations. Study 2 (undergraduates) and Study 3 (professional investigators) employed a mock industrial investigation and found that *prior* knowledge about worker or equipment safety biased undergraduate- and professional-investigators' responses. However, bias was effectively reduced with "tunnel vision education." Professional investigators demonstrated a greater sophistication in their investigative decision making compared to undergraduates. The similarities and differences between undergraduate and professional responding are discussed.

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INTRODUCTION

> On the last day of his life, Ted Gramlich got up early and kissed his girlfriend goodbye… He met his fellow loggers and they drove up into the bush…he hiked through the woods and started falling trees, just like he always did. But that afternoon, a tree came down the wrong way and hit Ted Gramlich. He rolled eighty feet down the mountain. He died before reaching the hospital. (Enright, 2006 p. 1)

The death of Ted Gramlich, like so many occupational deaths, should have been prevented. In 2007, Canadian statistics reveal that two out of every one hundred workers were injured on the job, and approximately five workplace deaths occurred every working day[1] (AWCBC, 2009). United States findings are equally concerning as 5,071 people were killed in 2008 as a function of going to work [United States Bureau of Labor Statistics, 2009]. Prevention of workplace incidents[2] begins with understanding what causes them; knowledge of cause leads to identification and correction of the failing element(s) [Det Norske Veritas (DNV), 2003; Vincoli, 1994]. Hence, the information gleaned from the post-incident investigation is fundamental to unearthing the cause of the event. Recent literature has proposed exploring the psychological underpinnings of the

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[1] There were 1,055 workplace deaths in Canada in 2007; the 5 workplace deaths per day is based on Canadians working an average of 230 days a year [Association of Workers' Compensation Boards of Canada (AWCBC) 2009].

[2] I chose not to use the term "accident" in the writing of this dissertation. Rather, throughout this document I use the terms "industrial incident", "industrial event" or "adverse workplace event" to refer to an unintentional critical happening resulting in equipment, production, or employee damage or loss. Sanders and McCormick (1993) highlight that definitions of the term "accident" typically connote that the event was "unexpected" or happened by "chance." Incident investigations attempt to find the underlying causes of adverse events so that preventative intervention may be instituted. Thus, terms such as workplace incident or adverse workplace event are more consistent with the notion that there are underlying causes to adverse events that can be identified and controlled for.

The materials in Study 2 and Study 3 were modeled on real investigation reports. The industrial investigation literature still regularly uses the term "accident" thus, I used this term in the on-line investigation material presented to participants.

industrial incident investigation as an approach to injury prevention (Kelloway, Stinson, & MacLean, 2004; Weegels, 1998). The current research extends this literature and explores the psychology of those investigating the industrial event.

The occupational health and safety literature states clearly that factors such as biases and heuristics facilitate human error for both the employee (GEMs framework; Reason, 1990) and the investigator (Dekker, 2006). Currently, much of the psychological literature dedicated to the social-cognitive factors that affect investigators' decision making is housed in a criminal investigation context (e.g., Ask & Granhag, 2005; Dahl, Brimacombe, & Lindsay, 2009; Kerstholt & Eikelboom, 2007; Lindsay, Nilsen, & Read, 2000; MacLean, Brimacombe, Alison, Dahl, & Kadlec, accepted for publication pending final revision). Industrial and criminal investigators are similar in that they both unearth evidence and build a case, however, these two groups of investigators also vary in a few important ways. Unlike criminal investigators, industrial investigators are the collectors of evidence as well as triers of the facts; they typically allocate cause to more than one element in the scenario (e.g., worker, equipment, environment), and they tend to have personal knowledge of the elements involved in the incident (Vincoli, 1994).[3] Psychological researchers have demonstrated that preconceived ideas are potent influences in the criminal scenario (e.g., Meissner & Kassin, 2004; 2002). The current pioneering research explores the effects of a priori opinions in *industrial investigation.*

The current research investigates how preconceived notions of workplace safety regarding people or machinery can influence the collection and interpretation of evidence as well as conclusions about cause in an industrial incident scenario. My research

[3] Knowledge of the subjects involved in an event also happens in the criminal scenario with repeat offenders.

investigates the unhelpful or biasing influence of contextual knowledge; however, it also seeks ways to obtain objective judgments in the face of such bias. The current research explores bias in industrial investigation via three studies and addresses the following research questions: (1) What are real industrial investigators' *theories* about how prior knowledge affects their information collection, interpretation, and decision making? (2) How *does* prior knowledge regarding people or machinery influence investigative information collection, interpretation, and conclusions about cause? (3) Can education work as an effective debiasing protocol? and (4) Do undergraduate- and professional-investigators differ in their reporting? This research exclusively considers the information gathering and the evidence assessment activities of the industrial investigation.

Comprehensive research approaches issues using a variety of sources and methodologies. This philosophy led me to include both industrial investigation professionals (Study 1 and Study 3) and undergraduate students (Study 2) as participants. Additionally, my research used varied methodologies, both survey (Study 1) and experimental design (Study 2 and Study 3). The survey format of Study 1 allowed me to collect the opinions of industrial investigators. Investigators commented on what information they typically have prior to an investigation and how that prior knowledge affects their investigative judgments. I used an experimental design in Study 2 and Study 3 to test: how prior knowledge influenced the investigation process, and the debiasing potential of an education intervention. In Studies 2 and 3 I provided participants with information indicating that equipment or a worker had a history of unsafe behaviour and then asked them to engage in a simulated investigation in which they considered evidence and rendered conclusions about cause. This experimental procedure afforded me the opportunity to track the trail of bias from initial assumptions, through evidence collection, to final investigative deductions.

Table 1. *Participants and Formats of Study 1, 2 and 3.*

Study	Participants	Methodology
Study 1	Industrial Investigators	On-line Questionnaire
Study 2	Undergraduate Students	Experimental Design
Study 3	Industrial Investigators	Experimental Design

Investigator Hypothesis Generation

Industrial investigation manuals instruct that “early hypotheses are necessary to guide evidence collection” (DNV, 2003, Section 10 pg 1). Research supports that having working hypotheses enhances accuracy in diagnostic exercises (Norman, Brooks, Colle, & Hatala, 1999). Psychological research warns, however, that once an attitude has been formed, individuals tend to seek, interpret, and create information to support those preconceived notions (Nickerson, 1998). Psychologists refer to the tendency to seek information that supports our beliefs while ignoring disconfirming information as confirmation bias (Evans, 1989; Nickerson, 1998); the legal literature dubs this “tunnel vision” (Department of Justice Canada, 2005; Findley & Scott, 2006).

Tunnel Vision

> There is tunnel vision in this industry . . . I have done investigations where you get going along a path and you are right there and then one little fact comes up and you say “wait a sec, that does not make sense” and you have gone down this path . . . and you say “wow, we’re wrong, we’re wrong, totally wrong.” (Personal communication, Industrial Investigator, MacLean, Brimacombe, & Stinson, 2006)

My research focuses on two sources of bias in the industrial investigation, the fundamental attribution error and personal prejudices. Focal in individual decision making is people's tendency to attribute the behaviour of others to the others' personality traits or dispositions as opposed to elements of the situation (Nisbett & Ross, 1980). For example, an observer seeing a car driving erratically on the highway may conclude that the driver is reckless and enjoys driving irresponsibly when in fact the driver may be experiencing a mechanical issue with his/her car. This phenomenon is known as the fundamental attribution error (FAE). Surprisingly, people often fall prey to the FAE even when circumstances adequately explain the person's behaviour (e.g., financial incentive; Nisbett, Caputo, Legant, & Marecek, 1973). Recent literature proposes reconceptualizing the FAE (i.e., people's tendency to *underestimate* the demands of the situation on an actor's behaviour) to consider it more of a correspondence bias (i.e., people's tendency to draw inferences that are correspondent to the actor's dispositions even when there are strong situational constraints; Gawronski, 2004; Gilbert & Malone, 1995). Regardless of how we conceptualize this bias it stands that it may manifest in the industrial investigation via investigators assuming worker fault and seeking information consistent with their attribution that human error caused the incident opposed to factors introduced solely by the situation (e.g., environment, machinery).

Investigators may also suffer from more idiosyncratic sources of prejudice. As a result of investigators' familiarity and experience with their industrial settings it is likely that their preconceived ideas of the people, equipment and environment involved in incidents in those settings will distort their *interpretation* of the evidence, and may lead investigators to *seek* information that confirms their prior beliefs. For example, perceiving a piece of machinery as old and inherently unsafe may bias an investigator's collection and interpretation of evidence.

Psychological Underpinnings of the Confirmation Bias

Psychological researchers speculate that the underpinnings of the confirmation bias are both motivational as well as a function of the limitations of human cognition. Nickerson (1998) proposes that confirmation bias may be explained by people's: (i) tendency to believe information that they desire to be true. This motivational strategy may be mediated by a cognitive strategy such as selective information search; (ii) information processing, i.e., people may not be able to accommodate more than one hypothesis at a time, confirmatory information may be more salient, or they simply do not think to explore alternatives; (iii) tendency is to assume a statement is true if they are without compelling evidence to the contrary; (iv) conditional frames of reference such that entertaining a possible hypothesis may increases people's belief in the likelihood that the statement is true; (v) error avoidance as there may be times when the consequences of proving a hypothesis as false may not be beneficial (e.g., eating a mushroom that one believes to be poisonous to challenge one's hypothesis); and (vi) involvement in environments where importance is placed on justifying one's beliefs rather than generating alternatives.

Cognitive dissonance may also be a key contributing factor to confirmation bias. Cognitive dissonance indicates that when one holds two cognitions that are inconsistent (e.g., "History tells me that Bill is a negligent worker, thus, he is most likely the cause of the incident" and "I have documentation that the machine was under repair for a malfunction that could have caused the incident"), one attempts to reduce that dissonance and regain cognitive consistency (Festinger, 1957). Cognitive dissonance causes discomfort and people try to release the tension of dissonance by using techniques such as changing their attitude to be consistent with the dissonant information, reducing the importance of the dissonant information, or adding new cognitions (Tavris & Aronson, 2007).

Tunnel Vision Prevention

The difficult issue of how to prevent tunnel vision has been tackled by the Canadian Department of Justice (2005) that proposed "the best protection against tunnel vision is a constant and acute awareness" (Canadian Department of Justice, 2005). Specifically, it recommended a separation of police and Crown functions as well as tunnel vision education for police and Crown Attorneys. Although the Department of Justice did not address investigation in an industrial context, its guidelines provide a comprehensive snapshot of current thinking about tunnel vision prevention.

Education

Tunnel vision education (TVE) is an intervention that pairs nicely with industrial investigation. The success of TVE as a debiasing strategy is reliant on the composition of the education. To satisfy the requisite investigator "awareness" TVE must inform industrial investigators about what tunnel vision is, how it may bias their information collection, interpretation of evidence, and decision making, and provide examples of tunnel vision.

The psychological underpinning of debiasing via awareness is represented by Wilson and Brekke's (1994) model of mental contamination. Bias, which Wilson and Brekke refer to as "contamination," is an unwanted mental process such as attributing event cause to the worker based on his or her history of unsafe behaviour rather than the evidence. If people are aware of their bias, they may debias their judgments by being: (1)

motivated to correct for the bias, (2) aware of the direction and magnitude of the bias, and (3) able to adjust their responses. Research demonstrates that awareness via warnings has reduced biased judgments in some situations but not others (e.g., Lampinen, Scott, Pratt, Leding, & Arnal, 2007). Wilson and Brekke (1994) suggest that these inconsistencies may be explained by the failure of forewarning to satisfy one (or more) of the 3 steps discussed above as necessary to avoid biased activity.

Informing investigators that tunnel vision could influence their investigative objectivity should motivate them to be vigilant against sources of bias. Investigators must then translate that awareness of potential bias into an accurate theory of *what* is biasing them, as well as *how* and *how strongly* they are being biased. Wegener and Petty's flexible correction model (1997) elaborates on how people's naïve theories about bias influence the direction and strength of their debiasing efforts. Findings indicate that awareness can lead people to adjust insufficiently (undercorrection), adjust too much (overcorrection), and/or fail to adjust their responses (Wegener & Petty, 1997; Wilson & Brekke, 1994). If, however, one is correct in one's assessment of the direction and strength of one's bias, successful adjustment can be made.

Awareness of tunnel vision should culminate in investigators employing the third, and final, step in Wilson and Brekke's (1994) model of mental contamination, the service of a strategy that allows people control over their responding [e.g., counterarguing (a contrasting, opposing, or refuting argument), Petty & Cacioppo, 1986]. A strategy that has been effective at aiding people in adjusting their responses and subsequently reducing bias in judgments explicitly asks people to "consider the opposite" (Anderson & Sechler, 1986; Lord, Pepper & Preston, 1984) or to consider *any* plausible alternative (Hirt &

Markman, 1995). To illustrate, in a series of 3 studies focusing on the explanation bias, Hirt and Markman (1995) found that considering any set of plausible alterative hypotheses debiased participants' likelihood judgments. Results indicate that the greater the plausibility of the alternative explanations, the greater the debiasing.

A TVE intervention focusing on awareness and considering alternatives may be a promising debiasing protocol for investigators. Gawronski (2004) considered the notion of theory-based corrections (Wegener & Petty, 1997; Wilson & Brekke, 1994) in his investigation of the correspondence bias and suggested that although perceivers may be aware that situational factors can influence people's behaviour they tend to persist in making dispositional inferences about a target's *attitude* or *ability* for one of three reasons. First, they may unaware of situational factors influencing the scenario. Second, they may lack motivation to engage in effortful thought required to consider situational influences. Finally they may perceive the situational variables as largely irrelevant factors to influencing how the person is behaving.

People's tendency to commit the correspondence bias has been reduced when they were motivated to put effort into their information processing (e.g., D'Agostino & Fincher-Kiefer, 1992; Fein, 1996; Yost & Weary, 1996) but not when they were simply cautioned to be wary of this bias affecting their judgments (e.g., Croxton & Miller, 1987). To illustrate, research has demonstrated that participants who were encouraged to considered alternatives (i.e., were provided with information that led them to be suspicious of the actor's ulterior motives) drew no dispositional inferences about the actor's attitudes. Alternatively, those not provided with information about the actor's motivations tended to infer that the actor's opinion was correspondent with their beliefs (Fein, Hilton, & Miller, 1990). Hence, educating participants about tunnel vision should not only increase participants' awareness of tunnel vision and motivate them to engage in correction but, if investigators consider alternatives that focus on situational factors (i.e., equipment or the environment), this may reduce their tendency to perceive the worker's behaviour as correspondent to the unsafe event. Thus, TVE may aid investigators in reducing biased decisions based on personal prejudices as well as the FAE.

The promise that considering alternatives holds as a debiasing protocol has led to a number of suggested interventions in applied settings. These protocols include the "crystal ball" technique proposed by Cohen, Freeman, and Thompson (1998) in which decision makers are asked to put their conclusion under scrutiny by pretending to gaze into a crystal ball that tells them that their decision is wrong. Another consider-alternatives intervention is proposed by Stubbins and Stubbins (2009) who suggest a four-step methodology by which investigators create a table explicitly stating the alternative narratives they are entertaining and identify how each piece of evidence supports or disconfirms each narrative. The Analysis of Competing Hypotheses (ACH) technique discussed by Heuer (1999) is a protocol that is very similar to the four-step method proposed by Stubbins and Stubbins (2009). The ACH's eight-step protocol was developed for the intelligence community and asks analysts to use a table to assess how each pieces of evidence supports or disconfirms each alternative hypothesis, as well as, teaches investigators to analyse their conclusions based on a few seminal pieces of evidence, discuss the likelihood of all the hypotheses, and identify markers that would indicate that events are progressing differently than expected.

These procedures via which a decision maker may consider alternatives are promising proposals; however, I am unaware of empirical research that has tested the majority of these protocols as debiasing techniques. Although a few studies are said to have assessed the efficacy of ACH, a recent report from the National Research Council (Thomason, 2010) notes that the ACH has yet to be validated (even though it has been used by the intelligence community for over 30 years).

In studies 2 and 3 I employed a TVE intervention to increase participants' awareness of tunnel vision; the intervention also asked participants to consider additional hypotheses when investigating. Comparing the aforementioned protocols to the TVE intervention employed in this research reveals that they provide a more structured approach to considering alternatives. The TVE intervention I used asked investigators to consider alternatives but did not provide them with a process to undertake this activity. Thus, TVE is more akin to the interventions found in the basic literature exploring phenomena such as explanation bias (Hirt & Markman, 1995), hindsight bias (Slovic & Fischhoff, 1977), and overconfidence (Koriat, Lichtenstein, & Fischhoff, 1980) where participants are asked to construct a hypothesis then consider an alternative outcome for the phenomenon in question. I was specifically interested in testing how TVE affected investigators' information collection, interpretation of evidence, decision making, and metacognitive judgments. The literature discussed above illustrates that the combination of awareness and considering alternative hypothesis should facilitate investigators in rendering more impartial judgments about the cause of an adverse workplace event.

The TVE intervention should also debias information seeking and interpretation of information. Asking participants to consider alternative hypotheses should increase the breadth of investigators' information collection. The literature states that people who favour a hypothesis tend to give preferential treatment to evidence that supports their beliefs and are biased to seek positive instances of the phenomenon (Nickerson, 1998). This tendency is known as "cherry-picking" in the industrial investigation literature

(Dekker, 2006). Investigators who entertain various simulations of what could have caused the industrial event should attend to information consistent with each one of those alternative scenarios, effectively increasing the breadth of information sought. Entertaining alternatives should also facilitate the objective assessment of evidence as each piece of information should be critiqued for its fit with the different event scenarios. Thus, TVE should reduce the narrow evidence collection and interpretation that accompanies tunnel vision.

My final area of inquiry was investigators' metacognitive judgments of their investigative performance. Namely, how did TVE affect investigators' (1) opinions regarding the influence of prior knowledge in their investigations? and (2) confidence in their investigative judgments? People typically believe that personal connection to an issue provides them with insight rather than bias (Ehrlinger, Gilovich, & Ross, 2005). I propose that participants should tend to maintain that their prior knowledge benefited their industrial investigation. Consistent with Ehrlinger et al.'s (2005) findings, participants who receive the TVE intervention should interpret previous knowledge as helpful. TVE investigators may accept that they were exposed to some biasing information but believe that they have taken conscious steps to correct for the influence of that information. This should result in TVE investigators assuming that the residual influence of a priori knowledge in their investigations is beneficial rather than hindering.

Last, I propose that investigators should be confident in their investigative judgments; people have a tendency to be overconfident in their appraisals of their behaviour (e.g., Hoffrage, 2004; Myers, 2002; Shafir & LeBoeuf, 2002). The incremental activities of proposing a hypothesis, collecting and assessing data, and rendering conclusions on the evidence should increase investigators' certainty in their final judgments about what caused the industrial event compared to their initial confidence ratings (see the reiteration effect; Hertwig, Gigerenzer & Hoffrage, 1997). Further, it is unclear whether providing investigators with TVE will alter their confidence in their judgments. The awareness provided by TVE may cause investigators' confidence to falter. Research on misinformation has demonstrated that warning participants that they encountered biasing information led to an overall reduction of confidence compared to those participants who were not warned about the misinformation (Highhouse & Bottrill, 1995). Alternatively, the act of considering one hypothesis or many alternative hypotheses should not alter participants' certainty in their judgments. Hirt and Markman (1995) demonstrated that participants who generated many simulations of an event did not differ in their confidence for the scenario they ultimately decided on compared to participants who generated only one hypothesis. Hence, participants' judgments may or may not vary as a function of the TVE intervention.

The literature presented above sets the groundwork for my research exploring the multifaceted topic of tunnel vision in industrial investigation. Moving the spotlight from criminal investigation, the current focus of investigative tunnel vision research, to the industrial scenario broadens the scope of inquiry concerning investigator decision making. This broader scope allows for exploration of those unique elements found in the industrial scenario (i.e., personal knowledge of the factors involved in the event, allocating cause to a variety of factors, serving as both investigator and arbitrator) and should lead to a fuller understanding of how bias can influence investigations.

STUDY 1

"Knowledge is insight. Sometimes objectivity is influenced; however, the benefits of insight out weighs [sic] the possible negative effects" (Personal communication, Industrial Investigator Forestry, 2006). People's theories about how information influences their behaviours guide the direction and strength of their debiasing efforts (Wegener & Petty, 1997). Via an on-line questionnaire, Study 1 asked real investigators for their theories of how prior knowledge of the people, machinery, and job position influences their investigations.[4] I was specifically interested in obtaining a data driven account of: (a) what knowledge professional industrial investigators have at the outset of their investigations, and (b) investigators' opinions of how this knowledge influences their investigations. Gaining an understanding of how investigators perceive the influence of a priori information illuminates how they may use this information in their investigations (i.e., overlooking it, actively employing it, or ambivalence to it) and provides a real world foundation to the experimental pursuits found in Studies 2 and 3.

Study 1 analysed investigators' responses to six questions. Recall that the literature indicates that investigators tend to be managers or supervisors, and they typically know the people, equipment, and/or position of those involved in the incident (Vincoli, 1994). Vincoli's (1994) statement is somewhat dated, and Study 1 establishes an up-to-date account of the knowledge typically held by investigators at the outset of their investigations. The questionnaire asked investigators to report: (1) the organizational position(s) of those who investigate industrial incidents in their organizations, and (2) the factors (i.e., equipment, employees, job position) investigators typically have knowledge

[4] The findings presented in Study 1 are a subset of the data obtained from the on-line questionnaire.

of prior to beginning the industrial investigation. Questions 3, 4, 5, and 6 were motivated by the literature that states selective information search and biased interpretation of available information are two behaviours that indicate confirmation bias in investigations (e.g., Ask & Granhag, 2005). Hence, I wanted to establish if investigators believe prior knowledge is influential in their investigative pursuits and if so, how. Thus, the questionnaire also asked investigators to self report on how prior knowledge of the people, job positions, and/or machinery involved in the incident influences their: (3) information collection, (4) interpretation of new information, (5) decision making, and (6) objectivity.

Method

Participants and Procedure

Participants in this study were 169 industrial investigators from across Canada. The breakdown of participants by industry is presented in Table 2. Also in Table 2 are the demographics of the entire investigator sample that began the questionnaire. The questionnaire was posted on-line so investigators could participate at their own convenience. All participants were recruited on a voluntary basis, through either the primary researcher contacting their organization or through the Canadian Society for Safety Engineering (CSSE) contacting them directly via a membership bulletin. In addition, the CSSE posted a link to the questionnaire on their website. The questionnaire took approximately an hour and a half to complete. By participating investigators had the option of being entered into one of two draws for $100 and receiving a summary of the findings of the questionnaire.

Table 2. *Investigator Demographics*

	Investigators who began the questionnaire (N = 186)	Investigators who participated in Study 1 (n = 169)
Gender	78% Male/ 22% Female	80% Male/ 20% Female
Age	*M* = 46.34, *SD* = 8.60	*M* = 46.48, *SD* = 8.45
	Med = 47.00	*Med* = 47.00
	Range = 25 – 69 yrs	Range = 25 – 69yrs
Years of Experience	*M* = 12.80, *SD* = 7.17	*M* = 12.73, *SD* = 6.98
	Med = 11.00	*Med* = 11.00
	Range = 2 – 30 yrs	Range = 2 – 30 yrs
Number of Incident	*M* = 22.29, *SD* = 51.11	*M* = 19.99, *SD* = 44.52
Investigations a Year	*Med* = 10.00	*Med* = 10.00
	Range = 0 – 500 investigations	Range = 0 – 500 investigations
Type of Industry		
Manufacturing	27.6%	26.6%
Service sector	21.6%	21.9%
Primary resources	17.3%	18.3%
Construction	13.0%	12.4%
Regulatory	9.2%	10.1%
Transportation/ warehousing	5.4%	4.7%
Public sector	4.9%	4.7%
Retail	0.5%	0.6%
Training	0.5%	0.6%

Note: See Appendix A for the complete list of industry affiliations for the entire sample of investigators.

Materials

Questionnaire

Following the consent form and the demographic questions, investigators responded to 129 questions that queried their experiences in industrial investigation. These questions probed the broad categories of: investigative methodology, the value of people's reports, interviewee characteristics, and investigator knowledge of memory issues. A 6-item subset of the 129[5] questionnaire items was analysed for Study 1. These items were located on pages four and five of the 18-page questionnaire[6].

First, participants were asked to select, in their opinion, the best person to conduct an industrial investigation from 4 options (an investigator who does not know the history of the people, equipment and/or job involved in the incident; an investigator who has some idea; an investigator who knows; or I don't know). Second, investigators reported what information they have prior to beginning the investigation. From a list, participants selected as many items as they wished (0-12) illustrating the knowledge they typically have of the worker(s), equipment, and/or job position before beginning an investigation (e.g., safety background of the worker, personal history of the worker, work history of the equipment, specifics of the job, no knowledge of the equipment). Third, investigators selected how prior knowledge of the people, equipment and/or job involved in the adverse event influences their: (1) information collection, (2) interpretation of new information, (3) decision making, and (4) objectivity (major influence; minor influence; no influence; or I don't know). Following each one of these four influence questions, investigators

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[5] The other 123 questionnaire items are not reported in Study 1 as they do not directly pertain to the present research on investigator decision making. The majority of questionnaire items queried investigators' handling of, and opinions regarding, eyewitnesses. Analysis of these items will inform and be included in future research.

[6] The questionnaire was constructed in consultation with the questionnaire development literature (Singleton & Straits, 1999; Schwarz, 1999).

could provide an open-ended response elaborating on how prior knowledge influences each one of these investigative behaviours.

Discourse Analysis

Discourse analysis was used to provide a refined assessment of investigators' open-ended responses. Investigators offered open-ended responses to items querying: (1) their own organizational position(s) and the organizational position(s) of any other investigators in their workplace, as well as four items querying how prior knowledge influences their: (2) information collection, (3) interpretation of new information, (4) decision making, and (5) objectivity. The discourse analysis technique uses the discourse itself as the foundation of the scoring keys; hence, it allows room for unexpected findings to emerge from the data.[7]

Once the scoring keys were developed, investigators' statements were placed into categories. Three analysts scored the investigators' responses using a detailed set of definitions and rules (See Appendix B for category information). To ensure objective application of these rules each statement was rated independently by two analysts, resulting in an inter-analyst agreement rate [number of statements correctly scored by both raters divided by the total number of statements (correct and incorrect)].

Ten percent of investigators' responses regarding organizational position of the investigator were scored and the inter-rater agreement was 100%. All of the investigators' statements regarding the role of prior knowledge in their investigative information collection, interpretation of new information, decision making, and objectivity were

[7] The techniques employed to analyse investigators' statements were acquired via discourse analysis training (Bavelas, 2004).

scored by two raters. These statements were scored on four separate scoring keys that were identical in their content categories. Inter-rater agreement ranged from 72% to 94% for the four scoring keys. The research duo resolved disagreements together, using a common interpretation of the definitions and rules. Post scoring, the information on the four keys was merged into a single master document that omitted any duplicate information obtained from the same investigator.

Investigators' statements were categorized into one of nine categories. The initial 3 categories represent the *influence* of prior knowledge in the investigation: positive, negative, or ambiguous (i.e., investigator does not indicate if the influence is positive or negative). The other 3 categories addressed investigators' beliefs as to how prior information *contributes* to their information seeking, interpretation of new information, and decision making[8]. Thus, each statement occupied a cell in the 9 cell design: 3 (influence: positive, negative, ambiguous) X 3 (contribution: information seeking, information interpretation, decision making). See Table 3 for further elaboration.

[8] When investigators were asked to elaborate on how prior knowledge influences their objectivity, the content of their statements described how prior knowledge influences their information seeking, interpretation, and decision making; no unique information was provided for objectivity. Thus, objectivity was not included as a variable in the analysis of the discourse.

Table 3. *Scoring Criteria for Investigator Responses*

Influence of Prior Knowledge	
Ambiguous	*Positive*
Prior knowledge influences the investigation but the investigator does not indicate if this is a benefit or a hindrance; E.g., "Depending on the level of trust you have in the equipment, the person or the job will have a direct influence on new information" Investigator # 35.	Investigator indicates that prior knowledge facilitates the investigation; E.g., prior knowledge "aids in accuracy" Investigator # 18.
	Negative
	Investigator indicates that prior knowledge hinders the investigation; E.g., "The danger is jumping to a conclusion that is wrong or seeking evidence to suit my perceptions" Investigator # 181.
Contribution of Prior Knowledge	
Interpretation of Information	*Information Collection*
Previous knowledge influences the investigators' assessment of the information.	Previous knowledge influences how, what, and where information is sought, as well as, impressions of the person collecting it.
Decision Making	
Prior knowledge influences investigators' conclusions about what happened during the event or what caused the incident.	

Results[9]

Investigators' Knowledge Base

Investigators reported their own organizational position(s), as well as the positions of any other investigators in their work environments. Table 4 illustrates that the majority of people investigating workplace incidents and near-misses are in-house personnel.

Table 4. *Workplace Investigators' Organizational Positions*

Category	Percent of Investigators'
Responses	
Internal to Organization: Manager; Supervisor; Health, Safety& Environmental Personnel	88%
Internal or External to Organization: Investigation Specialist, Consultant and/or Advisor	26%

Note: Investigators reported the position(s) of all the employees who typically investigate industrial incidents/near misses in their organizations. Investigators could indicate more than one position. Investigators responded to this item when completing the demographic items; thus, results reflect the sample that began the questionnaire, N = 186.

Additionally, investigators reported what knowledge they have prior to beginning the industrial investigation. Of the 153 investigators who responded to the question, 86% indicated that they have knowledge of the job position involved in the event, 70% reported that they typically have knowledge the people involved in the incident, and 76% reported that they are familiar with the equipment involved.

Influence of Prior Knowledge in the Investigation

Eighty-seven percent of investigators (133/153) indicated that prior knowledge of the people, equipment, and/or job has either a major or minor influence on their

[9] The sample sizes for each of the questions vary as not all investigators responded to every item used for Study 1.

investigations. Specifically, 70% indicated that prior knowledge influences their information collection, 63% their interpretation of new information, and 63% their decision making (*N* = 153). Investigators also reported that there is value in prior knowledge; 86% of participants stated that the *best* person to conduct an industrial investigation is an investigator who *knows* (46%) or has *some idea* (40%) of the people, equipment and/or job involved in the incident (*N* = 169).

Discourse analysis. One hundred and ten investigators provided open-ended responses to at least one of the four questions probing how prior knowledge influences information collection, interpretation, decision making, and objectivity. Investigators generated 294 unique pieces of information about how prior knowledge contributes to their investigations.[10] Discourse analysis was conducted on this information. Of central interest was the influence (positive or negative) that investigators see prior knowledge having in their investigations. Table 5 demonstrates that investigators most frequently indicated that prior knowledge benefited their investigation.

[10] Each of the categories (information collection, interpretation of information and decision making) had subcategories. Thus, investigators providing 2 pieces of information that addressed the same issue (e.g., information collection but different aspects of information collection e.g., what information is sought or how information is sought) received credit for providing 2 unique pieces of information. The discourse analysis of investigators' responses was far more detailed than what is reported in Study 1; for more information about what was found please see Appendix B and/or contact me.

Table 5. *Open-Ended Reporting of the Influence of Prior Knowledge in the Investigation*

Contribution	Total	Influence			Sig
		Ambiguous	Positive	Negative	
Information collection	128	15 (13)	91 (47)	22 (18)	p < .001
Interpretation of information	102	2 (2)	68 (49)	32 (26)	p < .001
Decision making	64	13 (12)	12 (12)	39 (32)	p < .001
Total	294	30	171	93	

Note: *N* = 294 unique pieces of information; p's indicate Chi Square results comparing the number of pieces of information across influence categories. Numbers in parenthesis are the number of investigators providing information contributing to the category from the *N* = 110 investigators responding to the question.

Chi Square analysis revealed that investigators' statements regarding the influence of prior knowledge on their investigations (i.e., ambiguous, positive or negative) had a significant relationship with the contribution they perceived prior knowledge as having in their investigations (e.g., information collection, interpretation, or decision making), X^2 (4, N = 294) = 61.35, p < .001, Cramer's V = 0.32. To further explore this relationship, I conducted follow-up Chi Square analyses.

As shown in Table 5, the greatest percentages of investigator responses were categorized in the information collection and interpretation of information categories rather than decision making, X^2 (2, N = 294) = 21.14, p < .001. Participants also significantly differed from chance in the amount of information they provided for each influence category X^2 (2, N = 294) = 101.82, p < .001. Participants provided far fewer statements that indicated prior knowledge had a negative influence or an ambiguous influence than statements indicating it is beneficial.

The aforementioned findings reveal that investigators provided 2.46 times as many pieces of information that indicated prior knowledge is beneficial when collecting their information as opposed to being a hindrance or providing an ambiguous statement about prior knowledge, X^2 (2, N = 126) = 82.70, p < .001. Similarly, investigators provided 2.00 times as many positive pieces of information about the influence of prior knowledge on the interpretation of information than a negative or an ambiguous statement, X^2 (2, N = 106) = 64.24, p < .001. In sharp contrast, analysis of investigators' statements regarding decision making revealed that they provided 1.56 times as many pieces of information that indicated prior knowledge *negatively* influenced their decision making rather than statements that indicated it positively affected decision making or an ambiguous statement about its affect on decision making, X^2 (2, N = 64) = 21.97, p < .001. Thus investigators indicated that prior knowledge helped their information collection and interpretation but hurt their decision making.

Hence, the greatest number of statements produced by investigators described the influence of prior knowledge on information collection and interpretation and these statements were mostly positive (rather than negative or ambiguous statements). An odds ratio analysis was conducted to further illuminate this observation and it demonstrates that investigators were 9.73 times more likely to report that prior knowledge is a benefit to their information collection and interpretation of information than a benefit to their investigative decision making. For a detailed account of the discourse analysis findings see Appendix B.

Discussion

Study 1 revealed the knowledge investigators have at the outset of an investigation and their opinions regarding how that knowledge contributes to their investigations.

Investigators reported that they typically have information about the subjects involved in the event before investigating the incident. As predicted, investigators reported that this background knowledge provides them with investigative insight rather than bias (although their comments suggested some sensitivity to the possibility that prior knowledge might negatively affect their decisions).

Investigator Knowledge Base

Investigators reported that industrial investigations are typically executed by employees internal to the organization i.e. managers, supervisors, health and safety personnel. This finding is consistent with the findings of Vincoli (1994). Investigators also reported that they tend to have knowledge of the job position, people, and equipment prior to beginning the investigation. Thus, investigation personnel seem to have both explicit and tacit knowledge of the organization, people, equipment, and job positions involved in the incident. This prior knowledge may enhance the investigation by streamlining evidence collection and providing a helpful context for information. However, this same contextual knowledge could potentially bias the investigative process by leading investigators to employ inaccurate assumptions when investigating.

Influence of Prior Knowledge on the Investigation: Benefit or Hindrance?

Consistent with Ehrlinger et al. (2005), the majority of investigators indicated that prior knowledge is beneficial to their investigations. Eighty-six percent of respondents reported that the *best* person to conduct an industrial investigation is an investigator who *knows* or has *some idea* of the people, equipment and/or job involved in the incident. Additionally, discourse analysis revealed that 58% of all investigators' statements about the influence of prior knowledge on the investigation indicated that it is beneficial (opposed to negative or ambiguous).

Influence and contribution of prior knowledge. When asked how prior knowledge influences their investigations, investigators' provided the greatest number of statements about evidence collection and interpretation; investigators made comparably fewer statements about the influence of prior knowledge on decision making. The greatest proportion of the information collection and interpretation statements reported that prior knowledge benefited these investigative activities. Hence, investigators were approximately 10 times more likely to make a statement that prior knowledge benefits their collection and interpretation of information than benefits their decision making. Investigators produced fewer statements about the influence of prior knowledge on decision making and the greatest proportion of these statements indicated that prior knowledge hindered effective decision making rather than facilitated it.

The aforementioned findings raise two questions: (1) why was there a higher frequency of reporting in the categories of information collection and interpretation compared to decision making? and (2) why did investigators endorse the benefits of prior knowledge in information collection and interpretation but not decision making? The answers to these questions may be found by exploring the features that make information about the influence of prior knowledge on the investigation memorable to investigators and thus, readily recalled on the investigation questionnaire.

Research has demonstrated that the more deeply or meaningfully information is processed the better it is retained (e.g., Craik & Tulving, 1975). Investigators may have access to a disproportionately large amount of personal information regarding their collection and interpretation of evidence because of their depth of processing when engaged in these investigative activities. Investigators may actively access prior knowledge when collecting and interpreting information in an attempt to develop leads or provide a context for the information they are considering. For instance, investigators may explicitly ask themselves “what do I know about the subjects involved?” when seeking more information about what caused the event or “when have I seen this before?” Such explicit and conscious assessment of prior knowledge during information collection and interpretation could produce easily recalled instances of how prior knowledge influences the investigation process. In addition, if a priori information leads investigators to seek and process information in ways consistent with their beliefs (Nickerson, 1998), this inventory of instances should be affirming and endorse that prior knowledge is mostly beneficial rather than hindering. An example of this phenomenon would be a workplace incident in which the investigator is aware of a recently injured worker’s addiction to alcohol. Knowledge of the worker’s addiction may lead the investigator to seek information about the worker’s performance on the job; when the investigator discovers that the worker did not do the necessary safety checks prior to the event she can once again reference her prior knowledge and interpret this information as evidence that the worker’s drinking contributed to the incident.

When queried about decision making, investigators produced fewer responses that mostly indicated that prior knowledge hindered, rather than helped, their judgments. This finding led me to consider the features that make decision making different from information collection and interpretation.

I propose that investigators may actively and explicitly (i.e., consciously) employ their prior knowledge when seeking and interpreting information; thus, workplace knowledge has a direct relationship with these activities. Investigators then utilize the collected and analysed information to derive their decisions. Asking investigators how prior knowledge influences their decision making is like asking the investigator from the example above how her knowledge of the worker's addiction to alcohol influenced the percentage of cause she chose to allocate to the worker for the industrial incident. As you can see this is a more abstract question than asking how prior knowledge influenced her information seeking and interpretation. Nibett and Wilson (1977) demonstrated that people are poor at understanding how they reach their cognitive conclusions. Hence, explicitly asking investigators to explain *how* their decision making is influenced by prior knowledge puts them in the difficult position of attempting to explain their cognitive processes. The challenge of explaining how one reaches his/her judgments may account for the reduced number of statements about decision making provided by investigators.

The results of Study 1 also showed that most of the investigators' statements regarding decision making indicated that prior knowledge hindered their conclusions. Once again I sought an explanation for this responding pattern by considering the features that make instances of prior knowledge and decision making memorable for investigators.

The characteristics that make the influence of a priori knowledge on decision making salient for investigators may be less affirming than what we see in information collection and interpretation. This is true chiefly because the feedback that investigators receive about their decision making may be primarily received when their conclusions are unsuccessful rather than effective. To illustrate, if an investigator reaches an inaccurate conclusion(s), implements an erroneous intervention(s), and despite the intervention(s), another incident occurs, the results would be memorable for the investigator involved. Alternatively, if an investigator reaches the "right" conclusion, establishes the correct cause(s) of the incident and implements safety protocols so that a similar incident does not happen in the future it is essentially a non-event; the investigator will never become aware of how correct his/her conclusions were. Similarly, if the investigator reaches a wrong conclusion and implements erroneous interventions but these interventions are never tested, it too is a non-event.

A number of investigators' statements stated the mantra "the facts are the facts." Investigators reflecting on what led to an inaccurate investigative conclusion may deduce that it was their decision making that was flawed not the evidence. Thus, the negative feedback produced from instituting an inaccurate safety intervention post-event may work to fortify investigators' recollections of these poor decisions. Research demonstrates that negative feedback produces a robust impact on memory; Gilovich (1983) showed that after a 3-week delay people's recollections were more robust for their losses than their wins. Thus, the negatively weighted feedback investigators may receive about their decision making, coupled with people's propensity to recall negative events, may explain investigators' disproportionately high reporting of the hindering, rather than helpful, function of prior knowledge on decision making.

A more macro approach to the findings of Study 1 reveals the possibility that this pattern of findings could be generated by a situational variable like media reports rather than the cognitive factors presented above. It is possible that people's general awareness of tunnel vision has been heightened due to sensational cases about wrongful convictions and the recent report by the Canadian Department of Justice (2005). This general knowledge could have led investigators to self-report that prior knowledge has a negative influence on their decisions but they may still rationalize their use of the information in the investigative process.

To summarize the findings of Study 1, investigators typically have knowledge of the people, job positions and equipment involved in the incident prior to beginning their investigations. Investigators acknowledge that this information influences their investigations and believe that this information is typically a benefit rather than a hindrance, at least when collecting and interpreting information. Investigators' tendency to view prior knowledge as a benefit suggests that they may be inclined to incorporate a priori information into their incident investigations. Incorporating prior knowledge may facilitate the investigation but it may also bias investigators' investigative efforts. Study 2 and Study 3 tested the biasing potential of prior knowledge and provided undergraduates and professional-investigators with a strategy to combat the influence of a priori knowledge in the industrial investigation.

STUDY 2

Employing an experimental protocol, Study 2 used undergraduate university participants to test: (1) how prior knowledge of people or machinery influenced participants' information collection, interpretation of evidence, and conclusions about incident cause, and (2) if an educational intervention about tunnel vision could work as an effective debiasing protocol. Participants in Study 2 engaged in a simulated industrial investigation in which they read details about an industrial event and considered two pieces of evidence about the incident. Before beginning the investigation, all participants were provided with a bias, i.e., information that led them to believe that the worker or equipment had a history of unsafe behaviour. At the outset and at conclusion of the investigation participants reported: (i) what caused the industrial incident, (ii) if they required more information to conclude what caused the event, (iii) if they did require more information, what information they would like, and (iv) how confident they were in their conclusions. Collecting these four measures at two points in the investigation allowed me to follow the trace of bias from initial hypotheses to final conclusions.

Finally, participants reported their impressions of how the unsafe background information influenced their investigative deductions.

Method

Participants and Design

One hundred and fifty-three undergraduate university students (38 men and 115 women) participated in exchange for bonus points in their 100- or 200-level courses. Participants ranged in age from 17 to 45 years (*M* = 19.95, *SD* = 3.02). Each participant was randomly assigned to one of two bias conditions, i.e., unsafe worker bias (*n* = 64) or unsafe tire bias (*n* = 58) and one of two education conditions, i.e., Tunnel Vision Education (TVE; *n* = 54) or TVE control (*n* = 68). During the course of the simulated investigation participants received two pieces of evidence, one that mostly supported worker fault and the other tire fault. Thus, this study is a 2 (Bias: unsafe worker bias or unsafe tire bias) X 2 (Education: TVE or TVE control) X 2 (Additional Information: tire evidence or worker evidence) mixed factorial design. Participation in this study took approximately 50 minutes. To maintain motivation during the experiment, participants were informed that they would be entered in a draw to win $100 if they reached the right investigative conclusions. In reality, all participants were entered in the $100 draw.

Materials and Procedure[11]

Study 2 was done entirely on-line. Participants arrived at the study session and were seated at a computer terminal. On the computer, participants entered the study's URL that opened the experiment's website. After reading and agreeing to the on-line consent form, participants advanced through a slide show that informed them that they were to assume the role of an industrial investigator in the study. The slide show notified

[11] See Appendix C for procedure summary for Study 2 and Study 3.

participants that their task was to render conclusions regarding what happened in, as well as what caused, an industrial incident they were to investigate. See Appendix D for introductory slideshow.

Unsafe Worker and Unsafe Tire Bias

Following the introductory slide show, participants received their bias. The bias manipulation masqueraded as a warm up exercise that participants were to complete before they began the true investigation. During the “warm up” each participant received two safety reports; one report discussed a tire and the other a worker. Participants in the unsafe worker bias condition received a safety report indicating that the “tire man” had a history of unsafe behaviour and a neutral safety report about the tire (i.e., tire labelled neither safe nor unsafe). The unsafe tire bias condition provided participants with a poor safety report about the tire and a neutral report about the “tire man.” Two photographs of tires and two photographs of workers were used and counterbalanced across participants. The order in which participants received the safety reports (neutral first or second) was also counterbalanced.

To ensure participants had attended to the information in the safety reports they then completed a short quiz that queried material that was presented to them in the worker and tire safety reports (i.e., how many incidents has the worker/tire been involved in over the last 3 years?, what safety rating did the tire receive on the safety performance measure?, and what safety rating did the tire man receive on the safety performance measure?). Participants then read a series of facts about a fictitious industrial event. Following the facts, participants generated a plausible hypothesis about incident cause. Participants in the Unsafe Tire Bias condition were asked to generate a hypothesis that implicated the tire as causing the incident and those with an unsafe worker bias created a hypothesis that implicated the tire man as the incident's cause. See Appendix E for bias materials.

Tunnel Vision Education (TVE)

Participants then viewed another slide show. Half of Study 2's participants were in the TVE control condition and viewed a slide show of illusions for 90 seconds. The TVE control slide show was 90 seconds in duration because it was estimated that participants in the TVE condition would spend approximately a minute and a half participating in the TVE intervention. The participants receiving TVE viewed a slide show that (i) defined tunnel vision, (ii) provided examples of tunnel vision in industrial investigation, (iii) encouraged participants to consider alternative hypotheses when investigating, and (iv) provided an example of poor decision making as a function of the actor failing to consider alternative hypotheses (based on Wason's 1960 rule discovery task). To ensure participants had attended to the information in the TVE intervention they then completed a short quiz that queried the material that was presented in the intervention. The quiz asked participants to select from multiple choice options: (1) the definition of tunnel vision, (2) how the investigators in the examples demonstrated tunnel vision, and (3) the recommended methods of preventing tunnel vision (i.e., being aware and considering alternatives). This quiz was a manipulation check ensuring that participants understood the concept of tunnel vision and how it could influence their investigation. See Appendix F for the TVE slide show and tunnel vision quiz.

Subject Verification Screen

All participants then received a screen with an image of a tire and a worker; these photos were consistent with the photos they had received on the safe and unsafe safety reports during the "warm-up exercise." Participants responded "yes" or "no" to a question asking if they had previously received information about these subjects. This screen was used: (i) to identify which participants did not recall that they had learned about these subjects so I could eliminate them from the final analyses, and (ii) as a cue for participants to mentally revisit the information they had learned about the safety history of the tire and worker before beginning the investigation. See Appendix G for an image of the subject verification screen.

Industrial Incident Summary

The true investigation began with a one-page summary of an industrial event. The summary described an incident in which a “tire man” was replacing a tire on a truck. The tire man fills the tire with air and, when the tire man reaches to shut off the air valve, the tire violently explodes striking a bystander working behind the tire man. The tire man is not injured but the bystander does sustain injuries. The report contained photos of the truck, the tire man and the bystander. The critical photo on the incident summary document was the one that matched the worker or tire photo participants received with their unsafe safety report during the bias manipulation. For example, participants in the unsafe worker bias condition received a safety report about an unsafe worker, and this same photo was presented on their incident summary. See Appendix H for event summary.

Questionnaire 1: Time 1 Investigative Conclusions

Following the incident summary, participants: (1) answered the open-ended question: What do you think could have caused the incident?, (2) allocated 100% of the cause for the event, (3) reported their confidence in their cause allocation, (4) reported the amount of additional information they required, and (5) reported the content of the information they sought. The open-ended question querying what could have caused the industrial incident was the second manipulation check for the TVE intervention. Recall that TVE should increase participant awareness of tunnel vision and lead participants to generate alternative hypotheses about the industrial incident. The quiz following the TVE intervention tested if participants were aware of tunnel vision (what is it, how it can affect the investigation, what to do about it). Asking participants to generate causes for the industrial event at Time 1 allowed me to test if TVE led participants to generate: (i) a greater number of alternative hypotheses about what caused the event and (ii) a set of hypotheses that were more diverse in content than those generated by TVE control participants.

After the open-ended item, participants responded to the four questionnaire items labelled 2-5 above that queried their investigative conclusions. First, participants allocated 100% of the direct cause for the incident to the tire man, tire, and/or other factor(s) (e.g., environment, process, bystander). Participants then rated their confidence in their cause allocation on a scale of 0-100 (0 = extremely unconfident to 100 = extremely confident) and indicated if they required more information (Likert scale: 1 = information is adequate; no more information is needed to 9 = information is not adequate; far more information is needed). If participants reported that they required more information they allocated 100% of the information they would like among the categories of tire man, tire, or other. See Appendix I for Questionnaire 1.

Filler Exercise

All participants then viewed a 60-second slide show of optical illusions.

Additional Information and Questionnaire 2

Two new pieces of information were then given to undergraduate-investigators, one that suggested that the tire man was at fault and one that suggested that the tire was faulty. Evidence was pilot tested to maintain a similar level of fault. In the pilot testing the evidence selected as supportive of tire fault produced an average cause allocation of 73% (*SD* = 27.42) to the tire and 22.40% (*SD* = 24.88) to the worker. The evidence supportive of worker fault produced an average cause allocation of 73.90% (*SD* = 27.98) to the worker and 16.86% (*SD* = 29.58) to the tire. It is important to note that although this evidence mostly supports either the tire or the tire man as the cause of the incident they are not exclusive to this cause and lend some support to the opposite contributing factor. Additionally, the order of the two pieces of information was counterbalanced. Following each new piece of information, participants rated how supportive this new evidence was to their original hypothesis of what caused the event (Questionnaire 2). See Appendix J for additional information and Questionnaire 2.[12]

Questionnaire 3: Time 2 Investigative Conclusions

Following the evaluation of the new evidence, undergraduate-investigators once again allocated 100% of the direct cause for the event among the tire man, tire, and/or some other factor(s) and rated their confidence in their cause allocation. Again, participants reported if they required more information on a 9-point Likert scale, and if so, they indicated what information they would like by allocating 100% among the categories of tire man, tire, and other. See Appendix K for Questionnaire 3.[13]

Questionnaire 4: Influence

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[12] Questionnaire 2 also asked participants to rate the value of the information provided to them. These 2 value items were not included in the discussion of results as they did not contribute any unique information beyond the information provided by the support items.

[13] In addition to the items discussed here, questionnaire 1and questionnaire 3 also asked participants to provide an open-ended account of what happened in the industrial event. Questionnaire 3 also asked participants for an open-ended account of their final conclusion of what caused the event. Participants then rated their confidence in their hypothesis of cause. These measures were collected as stimulus material for a future study. In addition, questionnaire 3 asked participants to rate on a scale ranging from 0-100 their confidence that they would be entered in the draw to win $100.

Participants were then asked to report if the safety report they received during the bias manipulation at the outset of the study guided their investigative behaviours in the simulated investigation. Specifically, participants reported on a 9-point Likert scale how influential the unsafe safety report information was when they: (1) allocated cause for the incident, (2) sought additional information (amount and type of information), and (3) interpreted the additional evidence (1 = not at all influential to 9 = extremely influential). Following each one of these questions labelled 1to 3 above participants were asked on another 9-point Likert scale *how* this information influenced them (1 = only negative influence to 9 = only positive influence). Participants were only given the option of responding to the second Likert scale if they had indicated on the initial question that the unsafe safety report influenced their responding. See Appendix L for Questionnaire 4.[14]

Results

Study 2 tested how prior bias and TVE influenced undergraduate participant-investigators' attributions of cause for an industrial event, confidence in cause allocations, information seeking, ratings of additional evidence, and interpretations of their investigative behaviour. This results section is divided into 4 subsections: (a) results of the manipulation checks, (b) participants' investigative findings at Time 1 (Questionnaire 1) and at Time 2 (Questionnaire 3), (c) participants' ratings of additional evidence (Questionnaire 2), and (d) undergraduate-investigators' metacognitve ratings of the influence of prior knowledge on their investigative judgments (Questionnaire 4). Within subsections b, c, and d the influence of both bias and education is discussed. See

[14] Questionnaire 4 also asked participants if the unsafe safety report influenced their written account of what happened in the event and, if so, how. Participants were also asked to rate how objective they were in their investigation. In addition, participants who received TVE were asked if receiving the education influenced their objectivity.

Appendix M for tables of the means and standard deviations of the analyses conducted in Study 2.

Table 6. *Content and Response Format of Study 2's Questionnaires*

Questionnaire	Content	Response Format
1	(i) What caused the event?	Open-ended
	(ii) Cause Allocation	100% among tire, worker, & other
	(iii) Confidence in Cause Allocation	9-point Likert scale
	(iv) More Information Sought?	9-point Likert scale
	(v) What Information Sought?	100% among tire, worker, & other
2	(i) Support of Evidence 1(Worker fault)	9-point Likert scale
	(ii) Support of Evidence 2 (Tire fault)	9-point Likert scale
3	(i) Cause Allocation	100% among tire, worker, & other
	(ii) Confidence in Cause Allocation	9-point Likert scale
	(iii) More Information Sought?	9-point Likert scale
	(iv) What Information Sought?	100% among tire, worker, & other
4	(i) Influence of the Unsafe Safety Report	9-point Likert scale
	(ii) Beneficial or Hindering Influence?	9-point Likert scale

Manipulation Checks

Four manipulation checks were included in Study 2. The first manipulation check comprised three multiple choice questions that quizzed participants about the content of the safe and unsafe safety reports. These three items followed the bias exercise. The second manipulation check was exclusively for those participants educated about tunnel vision. These participants answered four multiple-choice questions about the content of the TVE after they viewed the TVE intervention. The third manipulation check was the subject verification screen that was presented immediately before participants began the true investigation. Participants reporting that they had not seen the photos of the tire and worker before were removed from the analyses. A total of 31 participants (approximately 17%) were removed from analyses for providing at least one incorrect response on one of these three manipulation checks.

The last manipulation check was an open-ended question on Questionnaire 1 in which participants provided hypotheses about what could have caused the workplace event. This item tested if TVE led participants to generate: (i) a greater number of alternative hypotheses about what caused the event and (ii) a set of hypotheses that were more diverse in content, than those who were in TVE control. The open-ended responses of a subset of participants ($n = 48$) were assessed for the number of different hypotheses that each response contained and the content of those hypotheses (i.e. worker cause, tire cause, or other cause). Statements were scored by one rater who was blind to the conditions of each statement. Univariate analysis of the qualitative findings revealed that participants who received TVE did not provide more alternative causes for the event than TVE control participants [$F(1, 46) < 1$, $p > .03$]. Further, the content of the hypotheses that TVE and TVE control participants' proposed did not differ, i.e., number of hypotheses about the worker [$F(1, 42) < 1$, $p > .03$], tire [$F(1, 26) = 1.08$, $p > .03$], and other (no analysis was conducted due to small sample sizes).

Table 7. *Mean Number and Content of Hypotheses Provided by Undergraduate-Investigators in Each Education Condition*

	Education				
Hypothesis Type	*n*	TVE	*n*	TVE Control	Sig
Worker	22	1.14 (0.35)	22	1.14 (0.35)	*p* > .03
Tire	13	1.31 (0.85)	15	1.07 (0.26)	*p* > .03
Other	4	1.0 (0.0)	2	1.0 (0.0)	-----
Total		1.92 (1.14)		1.79 (0.72)	*p* > .03

Note: Many investigators did not provide hypotheses in all three content categories (tire, worker, or other). Hence, the total of the TVE and TVE control conditions do not equal the average of the worker, tire and other columns. Standard deviations in parentheses.

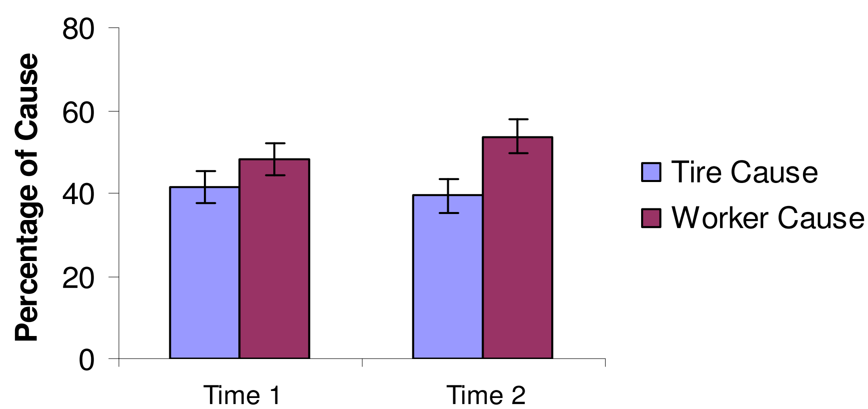
Investigative Findings: Time 1 and Time 2

Participants' allocations of cause for the incident, confidence in their allocation, and information seeking (amount of information sought and type of information sought) were collected at Time 1 (following receipt of the workplace incident summary) and at Time 2 (following the two pieces of additional information). Because of the multiple statistical comparisons carried out in Study 2 analyses were considered significant if they reached the conservative p-value $\leq$ 0.03. This subjective adjustment to the p-value was done to control for Type 1 error.

Cause Allocation

At Time 1 and Time 2 undergraduate-investigators distributed 100% of the cause of the incident among the tire, tire man or "other" category. A mixed factorial ANOVA tested the between-subjects variables of bias (unsafe worker bias or unsafe tire bias) and education (TVE or TVE control) and the within-subjects variables of cause (percentage of cause attributed to the worker or percentage of cause attributed to the tire) and time (cause at Time 1 or cause at Time 2).[15]

FAE. How undergraduate-investigators allocated cause for the industrial event demonstrates support for the role of the FAE in participant decision making. The results of the mixed factorial ANOVA demonstrated a significant main effect of cause [$F(1, 132) = 10.71$, $p < .01$, partial $\text{Eta}^2 = 0.08$]. On average, participants allocated a greater percentage of cause to the worker ($M = 50.61$, $SD = 26.13$) than to the tire ($M = 40.14$, $SD = 25.65$). Additionally, a main effect of time [$F(1, 132) = 5.59$, $p < .03$, partial $\text{Eta}^2 = 0.04$] demonstrated that on average, participants attributed a slightly greater percentage of cause to the worker and/or tire and less cause to "other" at Time 2 than at Time 1 (See Figure 1).



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[15] Correlational analyses tested the relationship between participants' support ratings of the additional worker and tire evidence (questionnaire 2) and participants' cause allocation, information seeking (amount and type of information sought), and confidence at time 2 (questionnaire 3). No significant correlations were found (r's ≤ 0.15 ns) thus, the support ratings were not included as covariates in the mixed factorial ANOVAs assessing these dependent variables.

Additionally, a mixed factorial ANOVA tested the between-subjects variable order of additional evidence (worker fault evidence first or tire fault evidence first) with bias (unsafe worker bias or unsafe tire bias) and education (TVE or TVE control) and the within-subjects variables of cause (percentage of cause attributed to the worker or percentage of cause attributed to the tire). Order of evidence did not produce a significant main effect or significant interactions with the other variables on participants' time 2 cause allocations [F's $(1, 114) \leq 2.04$, p's ≥ 0.17].

Figure 1. Undergraduate-investigator: Cause allocation at Time 1 and Time 2. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

The Time X Cause interaction was not significant [$F(1, 132) = 2.03$, $p = .16$]. Although non-significant, the pattern of descriptive findings found in Figure 1 demonstrates that, compared to Time 1 ($M = 49.33$, $SD = 26.12$), participants' allocation of cause to the worker at Time 2 ($M = 53.43$, $SD = 26.15$) contributed more to the main effect of time than their allocation of cause to the tire (Time 2 $M = 39.07$, $SD = 25.19$; Time 1 $M = 39.96$, $SD = 27.35$). The cause allocation findings presented above reveal that undergraduate-investigators had a preference to allocate cause to human error in their investigation as opposed to the tire or other factors.

Further findings from the cause allocation analysis reveal a near significant main effect of education [$F(1, 132) = 4.44$, $p = .04$, partial $\text{Eta}^2 = 0.03$]. TVE participants allocated less cause to the tire and worker ($M = 44.43$, $SD = 25.32$) and more cause to "other" factors ($M = 11.14$, $SD = 15.55$) than those participants in control (tire and worker $M = 46.32$, $SD = 26.76$; other $M = 7.36$, $SD = 10.44$).

Results also demonstrate a Time X Cause X Bias X Education interaction [$F(1, 132) = 8.56$, $p < .01$, partial $\text{Eta}^2 = 0.06$]. My follow-up analyses explored how TVE and TVE control participants in the two bias conditions allocated cause for the event at Time 1 and at Time 2.

Time 1. Results indicate that at Time 1 participants' bias condition affected their cause allocations [Time 1: Cause X Bias interaction $F(1, 132) = 48.72$, $p < 0.01$, partial $\text{Eta}^2 = .27$]. Figure 2 demonstrates that participants with an unsafe worker bias allocated a significantly greater percentage of cause to the worker ($M = 61.32$, $SD = 21.38$) than to the tire [*M* = 26.51, *SD* = 20.24; $F(1, 70) = 54.78$, $p < .01$, partial $Eta^2 = .44$]. Conversely, participants with an unsafe tire bias allocated a significantly greater percentage of cause to the tire (*M* = 55.08, *SD* = 26.51) than to the worker [*M* = 35.84, *SD* = 24.45; $F(1, 62) = 9.67$, $p < .01$, partial $Eta^2 = .14$].

Figure 2 also demonstrates that contrary to my prediction, there was no Cause X Bias X Education interaction at Time 1 [$F(1, 132) < 1$]. The TVE intervention did not lead participants' with an unsafe worker bias nor an unsafe tire bias to vary significantly in their allocation of cause.

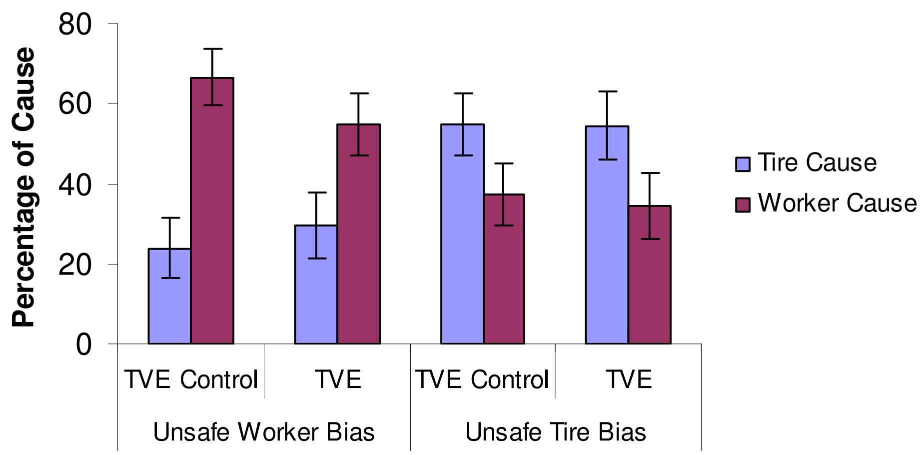

Figure 2. Undergraduate-investigator: Cause allocation, bias and education at Time 1. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

Time 2. Findings indicate a significant Bias X Cause X Education interaction at Time 2 [$F(1, 132) = 17.11$, $p < 0.01$, partial $Eta^2 = .12$]. Hence at Time 2 the Bias X Cause interaction was explored separately for those in TVE control and those in TVE.

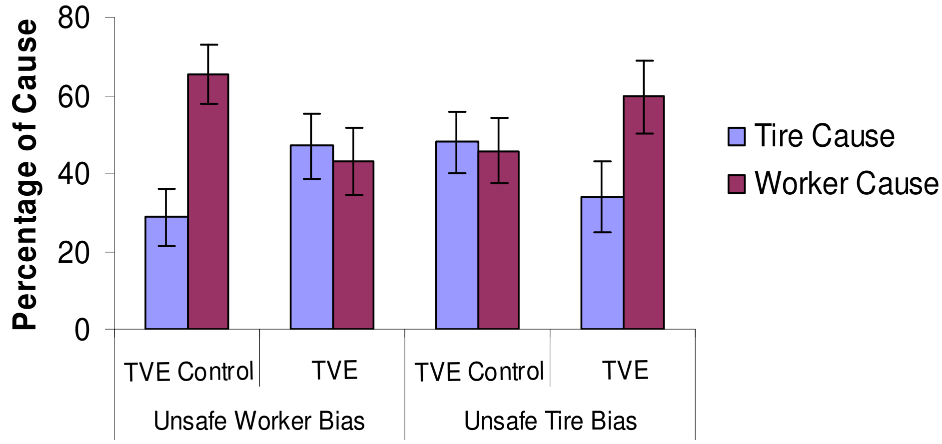

Figure 3. Undergraduate-investigator: Cause allocation, bias and education at Time 2. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

Figure 3 demonstrates that TVE control participants in the unsafe worker bias condition attributed significantly more cause to the worker than the tire [F(1, 39) = 33.72, $p < 0.01$, partial $Eta^2 = .46$]. In contrast, those who received TVE did not significantly differ in their allocation of cause at Time 2 [$F(1, 31) < 1$].

Contrary to my prediction, at Time 2 TVE control participants with an unsafe tire bias did not significantly differ in their cause allocation [$F(1, 34) < 1$]. In contrast, TVE participants did significantly differ [$F(1, 28) = 11.62$, $p < 0.01$, partial $Eta^2 = .29$]. Those who received the TVE intervention with an unsafe tire bias attributed more cause to the worker at Time 2 than to the tire.

In sum, participants' Time 1 and Time 2 cause allocation findings reveal that TVE slightly increased the amount of cause participants allocated to factors other than the tire and the worker (compared to control). Further, TVE did not reduce the impact of bias on participants' cause allocations at Time 1. At Time 2, however, TVE effectively reduced biased cause allocations for those with an unsafe worker bias but not for those with an unsafe tire bias.

Confidence in Cause Allocation

Scatterplots indicated no relationship between confidence and cause allocation. Thus, participants who partitioned their cause relatively equally amongst the tire, worker and “other” were no more or less confident than those participants who allocated most of their cause to one factor (worker, tire or other). A mixed-factorial ANOVA tested the relationship between the between-subjects variables of education and bias and the within-subjects variable of time of confidence rating in cause allocation (confidence Time 1 or confidence Time 2).

Bias produced no effect on participant confidence [$F(1, 149) < 1$] but education did significantly influence participants’ confidence in their cause allocations [$F(1,149) = 6.62$, $p = .01$, partial $\text{Eta}^2 = .04$]. Overall, TVE participants were significantly less confident in their cause allocations ($M = 68.97$, $SD = 20.91$) than participants in TVE control ($M = 75.94$, $SD = 16.89$). Findings also reveal a main effect of the within-subjects variable time of confidence rating in cause allocation [$F(1,149) = 57.18$, $p < .01$, partial $\text{Eta}^2 = .28$]. Undergraduate-investigators were more confident in their cause allocations at Time 2 ($M = 78.50$, $SD = 16.69$) than at Time 1 ($M = 67.32$, $SD = 21.37$).

Seek Additional Information?

At Time 1 and Time 2 undergraduate-investigators indicated on a 9-point Likert scale if they required more information to conclude the cause of the event (7 = information is slightly adequate, some more information is needed; 5 = information is somewhat adequate, a little more information is needed; 3 = information is mostly adequate, more information would be nice but it is not needed). A mixed factorial

ANOVA tested the between-subjects variables of bias and education and the within-subjects variables of time of satisfaction rating (satisfaction with the evidence at Time 1or satisfaction with the evidence at Time 2).

The findings reveal a significant main effect of the within-subjects variable of time of satisfaction rating [$F(1, 149) = 277.12$, $p < .01$, partial $\text{Eta}^2 = 0.65$]. Participants reported that they required more information to conclude cause at Time 1 ($M = 6.10$, $SD = 2.01$) than at Time 2 ($M = 3.58$, $SD = 1.93$). Results from this factorial ANOVA also demonstrate that participants were not entirely satisfied with the information they received in the investigation as their mean scores indicate that they required more information at both Time 1 and Time 2. The factorial ANOVA also demonstrated a main effect of the between-subjects variable education [$F(1, 149) = 11.63$, $p < .01$, partial $\text{Eta}^2 = 0.07$]. TVE participants reported that they required significantly more information to conclude what caused the incident ($M = 5.37$, $SD = 1.95$) compared to those in control ($M = 4.43$, $SD = 1.89$).

What Information was Sought?

Participants then reported what information they sought by allocating 100% of the new information they required amongst the tire, tire man or "other" category. A mixed factorial ANOVA tested the between-subjects variables of bias and education and the within-subjects variables of percentage of information sought (information regarding the worker versus the tire) and time of information seeking (Time 1 or Time 2).

Results reveal a significant main effect of information sought [$F(1, 104) = 9.01$, $p < .01$, partial $\text{Eta}^2 = 0.08$]. Participants sought more information about the worker ($M = 43.61$, $SD = 23.18$) than the tire ($M = 34.78$, $SD = 20.51$). In addition, the results presented in Figure 4 demonstrate a significant Time of Information Seeking X

Percentage of Information Sought interaction [$F(1, 104) = 25.29$, $p < .01$, partial $Eta^2 = 0.20$]. Follow-up analyses reveal that at Time 1 the amount of information undergraduate-investigators requested regarding the tire or the worker did not significantly differ [$F(1, 104) < 1$]. At Time 2, however, participants requested significantly more worker information than tire information [$F(1, 104) = 23.81$, $p < .01$, partial $Eta^2 = 0.19$].

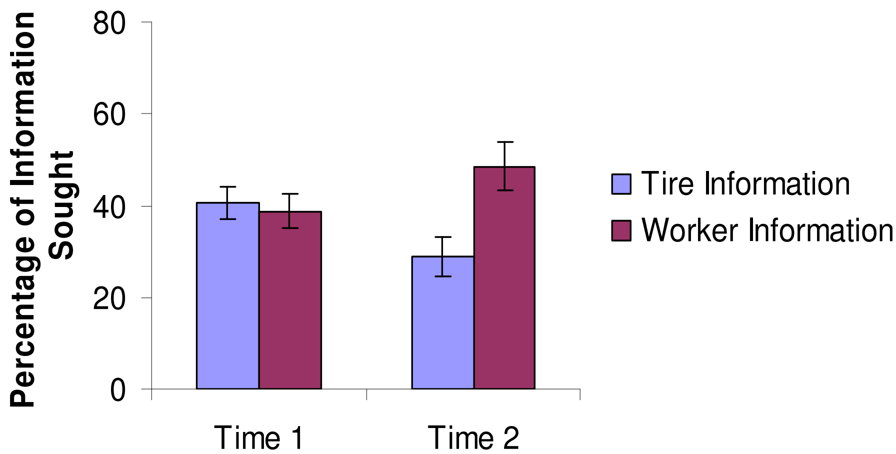

Figure 4. Undergraduate-investigator: Type and amount of information sought. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

Additional Evidence

Undergraduate-investigators received two pieces of information after their first and before their second Investigative Findings questionnaire. One piece of evidence suggested that the worker was at fault for the adverse event and one suggested that the tire was faulty. Participants rated how supportive this new evidence was to their original hypothesis of what caused the incident on a scale where 5 = neutral; information did not support or discount what I originally determined, and 7 = supportive; information mostly reinforced what I had originally determined.

A mixed factorial ANOVA was conducted using the between-subjects variables of bias and education and the within-subjects variable of evidence support (evidence of worker fault or evidence of tire fault). There was no significant main effect of education [$F(1,149) < 1$]. A significant main effect was found for the between-subjects variable bias [$F(1, 149) = 7.04$, $p < .01$, partial $Eta^2 = 0.05$]. Participants with an unsafe tire bias rated the additional information as slightly more supportive ($M = 6.04$, $SD = 1.83$) than those with an unsafe worker bias ($M = 5.75$, $SD = 1.91$). The within-subjects variable evidence support also produced a significant main effect [$F(1, 149) = 7.65$, $p < .01$, partial $Eta^2 = 0.05$]. Participants rated the evidence indicating that the tire caused the incident as slightly more supportive ($M = 6.35$, $SD = 1.86$) than the evidence indicating worker cause ($M = 5.67$, $SD = 1.91$). Thus, although there was some variation in how participants viewed the support of the evidence (variation by bias and type of evidence) my findings reveal that no matter how participants allocated cause for the incident (e.g., worker cause 70% and tire 30% or tire cause 70% and worker 30%) participants interpreted both pieces of evidence as supportive of their original hypothesis of event causation.

Interpretations of Investigative Behaviour

I asked participants if the unsafe safety report provided at the outset of the study influenced their behaviours in the simulated investigation and, if so, how (benefited or hindered). Participants indicated on a 9-point Likert scale (5 = somewhat influenced and 7 = highly influenced) how the unsafe worker or unsafe tire safety report influenced their: (1) allocation of cause for the event, (2) the amount of additional information they required to conclude what happened, (3) the content of that additional information, and (4) their interpretation of the additional evidence. I created an “influence” variable that represented participants’ average scores on these four items.

A univariate ANOVA assessed how bias and education affected undergraduate-investigators' reporting on the influence variable. Overall, all but 2 participants ($N = 151$) reported that the unsafe safety report influenced their investigative behaviours *(M* = 5.21, *SD* = 1.29). Findings reveal no significant Bias X Education interaction [$F(1, 149) < 1$] or main effect of education [$F(1, 149) < 1$] but findings do reveal a significant main effect of bias [$F(1, 149) = 6.14$, $p < .03$, $Eta^2 = 0.04$]. Those with an unsafe tire bias indicated that the unsafe safety report influenced them significantly more ($M = 5.49$, $SD = 1.17$) than those who received an unsafe worker bias ($M = 4.97$, $SD = 1.36$).

Participants who reported that they were influenced by the unsafe safety report then rated, on another 9-point Likert scale, *how* their cause allocation and interpretation of information was influenced (5 = moderately negative/ moderately positive and 7 = mostly positive). This benefit or hindrance rating was given by participants immediately after they reported that the unsafe safety report influenced their behaviour (e.g., allocation of cause, interpretation of additional information). A "Benefit/Hindrance" variable was created which represented the mean of participants' reporting on these four items.

Findings revealed that participants perceived the unsafe safety report as slightly beneficial to the investigation ($M = 5.71$, $SD = 1.19$). ANOVA results demonstrate a main effect of bias [$F(1, 147) = 8.28$, $p < .01$, $Eta^2 = 0.05$]. Participants who received unsafe tire information viewed the information as more beneficial ($M = 6.01$, $SD = 1.22$) than those who received unsafe worker information ($M = 5.44$, $SD = 1.17$). There was no main effect of education nor was there an Education X Bias interaction [$F's(1, 147) < 1$].

Discussion

Study 2 found that a priori knowledge can bias undergraduate-investigators' conclusions but that tunnel vision may be moderated by an educational intervention. My bias manipulation provided participants with information that a worker or tire had a history of unsafe behaviour. This historical information about worker or tire safety was immaterial to the simulated investigation and should not have biased participants' investigative judgments. Objective appraisal of the evidence should have resulted in participants concluding that both the tire and worker were equally culpable for the event; however, this was not the case. Outlined below is a discussion of how bias and education influenced participants' investigative outcomes.

Bias

A priori knowledge influenced participants' cause allocations, information seeking, and interpretation of additional information. Participants demonstrated tunnel vision in their cause allocations at Time 1 by attributing significantly more of the incident's cause to the factor for which they received unsafe background information (tire or worker). Interestingly, those with an unsafe worker bias showed greater polarization in their allocation of cause between the worker and tire than those with an unsafe tire bias (i.e., unsafe worker bias condition: worker 58%, tire 32%; unsafe tire bias condition: tire 48%, worker 43%). These descriptive results are the first to touch on a finding that I will revisit in my discussion of the experimental findings of Study 2; participants' tendency to allocate cause to human error (the FAE).

Participants with an unsafe worker bias may have been willing to allocate a larger percent of incident cause to the worker because they harboured a unidirectional bias. Recall that the fundamental attribution error (FAE) may guide participants to view worker fault as a contributing factor to the workplace incident. To be clear, participants with an unsafe worker bias may have had an unambiguous prejudice towards the worker in this simulated investigation scenario; it is possible that the FAE and the unsafe worker safety report aligned to guide participants' conclusions that the worker was the most probable cause of error. Alternatively, participants with an unsafe tire bias may have harboured both the FAE and a predisposition to see the tire (due to the unsafe tire safety report) as the cause of the event, thus they may have been effectively harbouring two offsetting biases. If participants in the unsafe tire bias condition maintained dual biases, it provides a sound explanation for why they demonstrated greater moderation when allocating cause to the tire and the worker.

Participants were also asked if they required more information about the event to determine what caused it, and if so, what information they would like. Findings reveal that all participants sought more information about the incident at Time 1 (after the incident summary) and Time 2 (after the additional information). This desire for additional information was significantly stronger when asked at Time 1 than at Time 2. Together these findings illustrate that participants were not satiated with the small amount of ambiguous information provided in the simulated investigation, and although they were more content after they had received the two pieces of additional information, they were still not totally satisfied. It is thus comforting to observe that the biases harboured by participants did not transform their impressions of a small amount of weak evidence into a concrete argument of culpability.

I predicted that bias would guide participants to collect a greater percentage of information about the subject of their prejudice (unsafe worker or unsafe tire); this prediction was not substantiated in Study 2's findings. Participants' bias condition did not affect the *type* of information they sought (i.e., tire man, tire or "other"). Rather, I found that at Time 1 participants requested an equal amount of information about both the tire and the worker. Thus, participants sought information about both of the subjects they had received previous information about (tire and worker). At Time 2, participants requested more information about the worker compared to the tire. This result may be linked to the FAE. Recall that participants demonstrated a general tendency to attribute cause to human error at Time 2. Hence, the fundamental quality of the FAE may have led participants to generally seek more information about, and attribute a greater percentage of cause to, the worker rather than the tire or other factors.

Participant bias also distorted undergraduate investigators' interpretation of additional evidence. Regardless of how they allocated cause at Time 1, all participants rated *both* pieces of information (one suggesting worker fault the other tire fault) as supportive of their hypothesis of what caused the event.[16] This finding is consistent with Nickerson (1998) who stated in his discussion of confirmation bias that people confirm their opinions in a number of ways, one of which is their tendency to see what they are looking for regardless of whether the information is present (Nickerson, 1998).

Finally, how did undergraduate-investigators interpret the influence of the unsafe safety report provided at the outset of the study? In Study 1 I showed that professional investigators largely reported that prior knowledge of the people, machinery, and job position helps their investigations (although their comments suggested the possibility that prior knowledge might negatively affect their decisions). Study 2's results reiterate the finding that people see contextual information as mostly helpful. Nearly all participants believed that the safety report benefited their investigative judgments. Interestingly,

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[16] My findings also revealed that participants with an unsafe tire bias reported that both pieces of additional information were more supportive of their original hypothesis than those with an unsafe worker bias. Additionally, participants interpreted the evidence indicating tire fault as more supportive of their original hypotheses than the evidence supporting worker. I interpret these two findings as spurious. Replication of this research with undergraduates did not confirm this finding and professional investigators did not demonstrate this responding pattern (Study 3).

participants who received an unsafe tire safety report felt that they were more influenced by the information and that the information was more beneficial to their investigation than participants who received an unsafe worker safety report. Research has shown that people often have a better memory for information that is inconsistent, rather than congruent, with their expectations (Stangor & McMillan, 1992). Information about an unsafe tire would be inconsistent with participants' tendency to attribute fault to human error produced by the FAE. This inconsistency between the participants' predisposed human error bias and the unsafe tire content of the safety report may have made the tire information more salient and readily recalled when participants were asked if and how this unsafe background information influenced their behaviours.

To summarize the influence of bias in Study 2, I found that participants were not able to eliminate the influence of preconceived opinions in their investigations. Unsafe tire and worker background information and the FAE seem to have guided participants' cause allocations and information seeking, and to have distorted their interpretation of new evidence. When asked if and how prior knowledge about the unsafe history of the worker or tire influenced their investigative behaviours, participants reported that this information did indeed influence them, and in a beneficial way. Those with an unsafe tire bias felt that the information was more influential and beneficial than those with an unsafe worker bias. These results demonstrate the power of preconceived notions in this simulated industrial incident investigation.

Education

Study 2 also tested if tunnel vision education (TVE) could minimize the influence of bias on participants' information seeking and investigative conclusions. The previous section illustrated how bias influenced participants' responding; however, the results of

Study 2 also demonstrate that tunnel vision was moderated by the TVE intervention. In the following discussion of the debiasing influence of TVE, I assess if TVE performed as anticipated, and outline the pattern of results that bias and education produced on participants' responses

Did TVE operate as anticipated? That is, did I find evidence that those who received TVE: (i) were aware of tunnel vision and how it can influence an investigation and (ii) actively considered more alternative hypotheses during the simulated investigation? Study 2's findings demonstrated that TVE did successfully increase participants' awareness of tunnel vision. Awareness of tunnel vision was tested via the quiz following the TVE intervention. Only participants who accurately answered all of the multiple choice questions on the quiz were included in the study. Alternatively, assessment of participants' open-ended responses to the Time 1 query "what could have cause the industrial event?" revealed that those who received TVE did not generate: (1) more alternative causes for the event or (2) causes implicating factors that differed from the causes provided by those in the TVE control condition. The results of Study 2, however, did reveal that TVE participants tended to allocated slightly more cause to "other" factors (M = 11%) than those in control (M = 7%). Taken together these findings suggest that the TVE intervention worked to produce participant awareness but they do not provide persuasive evidence that TVE led participants to produce more, or more diverse, alternative hypotheses about event cause. This conclusion, that TVE increased awareness but not necessarily consideration of alternatives, provides a helpful context for the following discussion of the influence of TVE on undergraduate-investigators' judgments.

Before I explore the effect of TVE on participants' final (Time 2) cause allocations I ask the reader to recall that participants who were in the unsafe worker bias condition should allocate more cause to the worker than the tire or other factors because of a unidirectional bias. Alternatively, participants in the unsafe tire bias condition should conclude that both the worker and the tire were causal for the workplace event because they may harbour dual biases. The unmitigated influence of bias at Time 2 is demonstrated in TVE control participants' allocation of cause. TVE control participants in the unsafe worker bias condition allocated a disproportionately high amount of cause to the worker (compared to the tire) and those in the unsafe tire bias condition allocated an equivalent amount of cause to both the tire and the worker. This pattern of findings supports the prospect that participants who were in the unsafe worker bias condition were biased to largely see worker fault and participants who were in the unsafe tire bias condition entertained both worker and tire fault.

TVE did not influence undergraduate-investigators' cause allocations at Time 1; however, TVE altered participants' reporting at Time 2. The pattern of findings at Time 2 suggests that TVE led participants to correct for the bias they were aware of (tire and worker bias provided at the outset of the experiment) and not for the more subtle human tendency to make judgements correspondent with situational factors (i.e., a judgement of human error produced by the FAE). Hence, participants in the unsafe worker bias condition effectively corrected for their bias because it unilaterally implicated worker fault; whereas, participants in the unsafe tire bias condition overcorrected for their tire bias and allocated a disproportionately high amount fault to the worker. Stapel, Martin, and Schwarz (1998) demonstrated a similar finding in their exploration of participants' judgments after blatant or conditional warnings of bias. Participants who were conditionally warned about bias ("correct for influences that you feel are biasing influences") corrected for salient sources of bias but not for subtle ones. Study 2's TVE intervention was similar to Stapel et al.'s (1998) condition warning as it cautioned participants about tunnel vision and suggested that they control for bias in their investigation.

Findings from the correspondence bias (FAE) literature further supports the pattern of findings found in Study 2. Specifically, participants simply warned about correspondence bias did not debias their judgements (Croxton & Miller, 1987; Study 2), whereas, participants made suspicious of the actor's motives (i.e., encouraged to consider ulterior motives) produced reports that demonstrated less bias (e.g., Hilton, Fein, & Miller, 1993). Hence, in Study 2 it may be that the awareness produced by TVE led participants to generate a theory about the strength and direction of their bias and participants corrected accordingly. Doing so may have been successful for participants with knowledge that the worker had an unsafe history but was unsuccessful for participants who received information about a tire with an unsafe history. Participants' failure to consider alternatives may have undermined the ability of the TVE to debias the FAE.

TVE warned participants about the narrow information collection that can accompany tunnel vision. The results of Study 2 revealed that TVE participants requested significantly more information about the workplace event compared to TVE control participants. TVE did not, however, lead investigators in a more balanced pursuit of information (worker, tire, or other). Recall that confirmation bias may lead people to seek information about, and attribute blame to, a hypothesis they favour (Nickerson, 1998). Drawing on this information about confirmation bias, I predicted that bias and education would have a similar effect on participants' cause allocation and information seeking. Specifically, TVE would lead to a more balanced pursuit of information and allocation of cause. I am uncertain why bias and education affected participants' information seeking and cause allocations differently. Although participants sought information that coincided with the subjects that they had received some information about (worker and tire) the amount that they required from these sources did not vary with the bias they harboured or the TVE intervention. Future research may wish to include a more sensitive information seeking exercise (e.g., allow investigators to select from many different pieces of information reflecting a breadth of content) to illuminate the nuances of how bias and TVE influence information seeking. Providing a more detailed test of how investigators' seek information may capture a clearer picture of how prior knowledge and education influences information collection.

Finally, I found that all participants were confident in their cause allocations and that they were more confident when providing their final, compared to their initial, allocation of cause. I was uncertain how education would influence participant confidence as research on warnings suggests that being warned about biasing information should reduce participants' confidence in their judgments (Highhouse & Bottrill, 1995) and research discussing considering alternatives suggested that confidence should remain constant between those who consider one versus many hypotheses (Hirt & Markman, 1995). Results from my TVE manipulation checks demonstrated that participants were successfully warned about tunnel vision. Thus, the findings of Study 2 fit with Highhouse and Bottrill's (1995) results and demonstrate that those who received a warning (TVE participants) were less confident than their counterparts who received no warning (TVE control).

The findings of Study 2 demonstrate that TVE successfully increased participant awareness that a priori information may have biased their investigative behaviours. This awareness led participants to seek more information about the event as well as generate a theory about the strength and direction of their bias and correct their responses accordingly when allocating cause for the industrial event. Correction was successful for participants given unsafe worker information at the outset of the study but unsuccessful for those who received unsafe tire information. Hence, TVE did not guide participants in the unsafe tire bias condition to allocate a similar amount of cause to the worker and the tire. In addition, TVE did not lead participants to be more consistent in their information seeking or alter their propensity to interpret all evidence as supportive of their hypothesis regardless of its suggestion of worker or tire fault.

Study 3 extended the findings from Study 2 and employed real industrial investigators in its exploration of how experience informs investigative judgments in the simulated industrial investigation exercise.

STUDY 3

In Study 3 a sample of professional-investigators engaged in the simulated industrial investigation exercise discussed in Study 2. Engaging professional-investigators in the same investigation activity as undergraduate-investigators allowed me to directly compare and contrast the influence of bias and education on these two groups of participants. I have reason to believe that experts will be susceptible to the biasing influence of my unsafe worker and unsafe tire contextual information. Previous research has found that expert finger print analysts' decisions about match or no-match were affected by biasing contextual information provided about the case (Dror & Charlton, 2006; Dror, Charlton, & Peron, 2006). In this research, four of five experts asked to re-analyse prints they had previously deemed a match changed their verdict to either no-match (3) or can't decide (1) when provided with information indicating that the prints had been involved in a crime where the suspect was falsely identified as the culprit (Dror et al., 2006).

Other literature exploring expert decision making leads me to also predict that experts should be more effective at the simulated industrial investigation exercise than undergraduates. Research has explored how novices differ from experts in decision making (see Phillips, Klein, & Sieck, 2007, for a review) and Klein (1999) summarized the differences by stating that experts are superior in two primary areas: pattern matching (ability to see constants across situations) and developing and running mental simulations. One of the factors that facilitate experts' ability to run mental simulations is the greater breadth and depth of domain-specific knowledge that they have compared to novices (Phillips et al., 2007).

Experts are people who have achieved outstanding skill in one particular domain, thus, experience alone does not make a person an expert (Phillips et al., 2007). The professional-investigators in Study 3 may or may not be industrial investigation experts, however, their general knowledge about investigation and industrial incidents should facilitate their performance in the simulated investigation beyond the performance of the undergraduates in Study 2. Professionals' domain-specific knowledge may enhance their assessment of what information is revealed in the data (and just as importantly, what is not revealed), as well as their ability to consider of alternatives. Thus, the tacit knowledge held by professionals about workplace investigation should lead them to produce more effective judgments in the investigation simulation than undergraduates.

Method

Participants and Design

Thirty-nine professional industrial incident investigators (29 men and 10 women) participated in exchange for a $6 Amazon gift certificate and entrance into a draw to win $100. Investigator recruitment was done in collaboration with the Canadian Society for Safety Engineering (CSSE). The CSSE distributed information about the study and the study's URL via their membership news email. Investigators who wished to participate entered the study's web address which brought them to the study's testing website. Participants ranged in age from 28 to 64 years (M = 46.74, SD = 8.71) and comprised 7 of WCB's 8 industry groupings: primary resources (n = 12), service sector (n = 7), construction (n = 6), public sector (n = 5), manufacturing (n = 5), regulatory (n = 2), training (n = 1), and transportation and warehousing (n = 1). Investigators' self-reported experience ranged from 1 investigation every 4 years to over 35 investigations a year (M = 12.58, SD = 9.09). As in Study 2, each participant was randomly assigned one of four experimental conditions: unsafe worker bias/TVE (n = 6), unsafe worker bias/TVE control (n = 12), unsafe tire bias/TVE (n = 10), and unsafe tire bias/TVE control (n = 11). All participants received both pieces of additional evidence.

Materials

Small adjustments were made to Study 3's materials from Study 2 to facilitate professional-investigators' participation. Pilot testing with professional-investigators (N = 8) revealed that they were: (1) inaccurately completing the warm-up exercise developed to institute the unsafe worker or unsafe tire bias and (2) allocating cause to direct (i.e., worker fault, equipment fault, procedure, and environment) *as well as* root causes of the event (e.g., supervision, management, training). This dissertation research is only interested in direct cause allocation. Hence, subtle adjustments were made to Study 3's materials to correct for these issues.

The warm-up exercise provided participants with an unsafe tire or unsafe worker bias. Participants were given two safety reports (one unsafe and one neutral) and then read facts about a fictitious workplace event. Participants were then asked to generate a plausible hypothesis about incident cause implicating either the tire (unsafe tire bias) or the "tire man" (unsafe worker bias). A number of the professional-investigators indicated that it was premature to generate a hypothesis about cause because they did not have enough information about the incident. Thus, to encourage investigators to generate a probable hypothesis I altered the instruction from: "Given your knowledge of the *tire man* (or *tire*) involved in this incident please generate a plausible explanation that supports that the *tire man* (or *tire*) was at fault for this incident" to "Imagine that you have done a thorough investigation of this incident and have considered all the evidence available. The evidence clearly indicates that the incident was a direct result of *substandard actions of the tire man* (or, *faulty equipment, specifically, a substandard tire*). Given your knowledge of the *tire man* (or *tire)* involved in this incident please describe how *the substandard actions of the tire man* (or a *faulty tire*) could have caused this incident." See Appendix N for professional-investigator bias manipulation.

Second, to encourage investigators to only allocate cause to direct causes of the event rather than more underlying (root) causes I added 3 slides to the introductory slide show. These slides defined and gave examples of direct and root cause as well as emphasized that this study was only interested in testing investigators' conclusions about direct cause(s) of the event (See Appendix O for professional-investigator introductory slide show).

In addition, I changed the wording of how professional-investigators were asked to allocate cause for the event at Time 1 (question 2 of Questionnaire 1) and Time 2 (Questionnaire 3). Undergraduate-investigators were asked to: "Please allocate 100% of the blame for the incident into the following three categories: Tire Man Fault, Tire Fault, Other Factors" and professional-investigators were asked to: "Recall that *direct causes* are the immediate causes of the incident (i.e., inappropriate actions, faulty equipment or a substandard working environment) not root causes (e.g., inadequate supervision or training, employee stress, poor maintenance). Please distribute 100% of the cause of this incident among the following three direct cause(s): Substandard Tire Man Action, Substandard Tire, Other Substandard Factors (i.e., equipment, action, or environment)." Appendix P contains the Questionnaire 1 and Questionnaire 3 that were used with professional-investigators.

Last, professionals indicated that they preferred the term "cause" rather than "blame." Thus, professional participants' materials were altered so that they allocated cause for the workplace incident rather than allocated blame or fault as undergraduate-investigators.

Results[17]

Manipulation Checks

The four manipulation checks that were included in Study 2 were also included in Study 3. Specifically the manipulation checks were the: (1) quiz following the bias manipulation, (2) quiz following the TVE intervention, (3) subject verification screen, and (4) open-ended question on Questionnaire 1 querying the potential causes for the event. Fifty-two professional-investigators began the experiment, four participants were

[17] See Appendix P for the means and standard deviations for Study 3.

removed for starting but not finishing the study, and nine (approximately 19%) were omitted for not accurately completing one or more of the manipulation checks labelled 1-3 above.

The fourth manipulation check asked professional-investigators to generate hypotheses for what could have caused the industrial incident. Again, I was interested if TVE led participants to generate: (i) a greater number of hypotheses about what could have caused the event, and (ii) a set of hypotheses that were more diverse in content, than those who were in the TVE control condition. Univariate analysis of the qualitative findings of participants' open-ended responses ($n = 24$) reveals that participants who received TVE did not provide more alternative causes for the event than TVE control participants [$F(1, 21) < 1$, $p > .03$]. Further, the content of the TVE and TVE control participants' hypotheses did not differ, i.e., number of hypotheses about the worker [$F(1, 20) < 1$, $p > .03$], tire [$F(1, 14) < 1$, $p > .03$], and other [no analysis was conducted due to small sample size]. Statements were scored by one rater.

Table 16. *Mean Number and Content of Hypotheses Provided by Professional-Investigators in Each Education Condition*

	Education				
Hypothesis Type	*n*	TVE	*n*	TVE Control	Sig
Worker	11	1.82 (0.75)	11	1.73 (1.19)	$p > .03$
Tire	10	1.10 (0.32)	6	1.0 (0.0)	$p > .03$
Other	7	2.14 (1.46)	2	1.50 (0.71)	-----
Total		3.46 (2.07)		2.55 (1.92)	$p > .03$

Note: Many investigators did not provide hypotheses in all three content categories (tire, worker, or other). Hence, the total of the TVE and TVE control conditions do not equal the average of the worker, tire and other columns. Standard deviations are in parentheses.

Investigative Findings: Time 1 and Time 2

As in Study 2, after participant-investigators received their unsafe worker or unsafe tire bias they read a summary of the workplace incident and reported their investigative findings (Questionnaire 1: cause allocation, confidence, information seeking). Then, after receiving and rating the support provided by two pieces of additional evidence, participants once again reported their investigative judgments (Questionnaire 3). The following results are participants' investigative judgments from Time 1 and Time 2.

Cause Allocation

At Time 1 and Time 2 professional-investigators distributed 100% of the cause of the industrial event to the tire, tire man or "other." As with Study 2 a mixed factorial ANOVA was used to test the between-subjects variables of bias (unsafe worker bias or unsafe tire bias) and education (TVE or TVE control) and the within-subjects variables of cause (percentage of cause attributed to the worker or percentage of cause attributed to the tire) and time (cause Time 1 or cause Time 2).[18]

The mixed factorial ANOVA demonstrated a main effect of cause [$F(1, 35) = 6.75$, $p < .03$, partial $Eta^2 = 0.16$], a main effect of education [$F(1, 35) = 7.27$, $p < .03$, partial $Eta^2 = 0.17$] as well as a Time X Cause X Bias interaction [$F(1, 35) = 5.39$, $p < .03$, partial $Eta^2 = 0.13$] and an Education X Bias X Cause interaction [$F(1, 35) = 10.50$, $p < .01$, partial $Eta^2 = 0.23$]. Follow-up analysis explored these main effects and

[18] Correlational analyses tested the relationship between participants' support ratings of the additional worker and tire evidence (questionnaire 2) and participants' cause allocation, information seeking (amount and type of information sought), and confidence at time 2 (questionnaire 3). The correlation between participants' confidence at time 2 and their rating of support for the tire evidence was significant ($r = 0.40$, $p < 0.03$) but, all other correlations between the items on questionnaire 2 and questionnaire 3 were non-significant (r's ≤ 0.15 ns). Thus, support ratings were not included as covariates in the mixed factor ANOVAs assessing the items found on questionnaire 1 and 3.

interactions further. See Appendix Q for figures of the Education X Bias X Cause relationship at Time 1 (Figure 7) and Time 2 (Figure 8).

FAE. The main effect of cause demonstrates that professional-investigators allocated significantly more cause to the worker ($M = 45.21$, $SD = 20.98$) than the tire ($M = 30.11$, $SD = 24.74$). Exploration of the Time X Cause X Bias interaction further illuminates how both bias and the FAE affected professional-investigators' allocations of cause.

Time 1. Results indicate a significant Bias X Cause interaction at Time 1 [$F(1, 35) = 7.26$, $p < .03$, partial $Eta^2 = 0.17$]. As illustrated in Figure 5, participants with an unsafe worker bias allocated more cause to the worker than the tire [$F(1, 16) = 21.16$, $p < .01$, partial $Eta^2 = 0.57$]. In contrast, professional-investigators with an unsafe tire bias did not significantly differ in their allocation of cause to the tire or the worker [$F(1, 19) < 1$].

Time 2. There was no significant Bias X Cause interaction at Time 2 [$F(1, 35) < 1$] but there was a main effect of cause [$F(1, 35) = 7.63$, $p < .01$, partial $Eta^2 = 0.18$]. At Time 2 participants allocated significantly more cause to the worker ($M = 50.51$, $SD = 25.63$) than the tire ($M = 27.56$, $SD = 21.71$). Although the Time 2 Cause X Bias interaction was non-significant, follow-up analyses revealed that participants with an unsafe worker bias attributed significantly more cause to the worker than the tire [$F(1, 17) = 6.58$, $p < .03$, partial $Eta^2 = 0.28$]. See Figure 5.

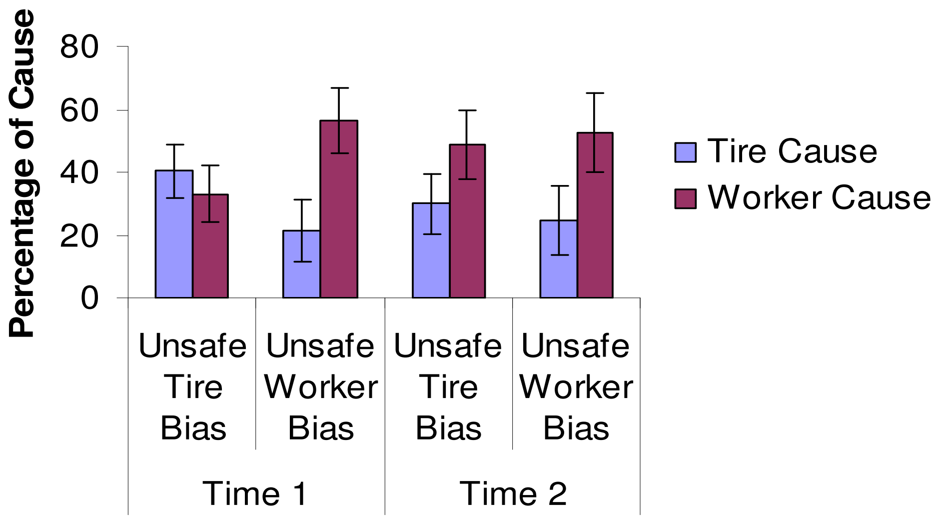

Figure 5. Professional-investigator: Bias and cause allocation at Time 1 and Time 2. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

Recall the main effect of education on professionals' allocation of cause. This main effect revealed that, similar to undergraduate-investigators, TVE control participants allocated more cause to the tire and the worker (M = 40.62, SD = 27.61) and less cause to other factors (M = 18.91, SD = 14.69) than those who received the TVE intervention (tire and worker: M = 34.70, SD = 18.41; other: M = 32.81, SD = 19.37).

Results of the cause allocation analysis also demonstrated an Education X Bias X Cause interaction. This interaction was explored by evaluating the Bias X Cause relationship for those professional-investigators who received the TVE intervention and those who were in TVE control.

TVE control. Control participants demonstrated a significant Bias X Cause interaction in their allocation of cause [$F(1, 21) = 11.07$, $p < .01$, partial Eta^2 = 0.35]. Figure 6 reveals that control participants in the unsafe worker bias condition allocated significantly more cause to the worker than the tire [$F(1, 11) = 42.97$, $p < .01$, partial Eta^2 = 0.80]. In contrast, TVE control participants in the unsafe tire bias condition did not statistically differ in the average amount of cause they allocated to the tire and the worker [$F(1, 10) < 1$]. A main effect of cause for participants in the control condition demonstrated an overall tendency for control participants to allocate cause to the worker ($M = 50.45$, $SD = 28.49$) rather than the tire ($M = 30.78$, $SD = 26.74$), $F(1, 21) = 5.71$, $p < .03$, partial Eta^2 = 0.21.

TVE. Participants who received the TVE intervention demonstrated no main effect of cause $F(1, 14) = 2.28$, $p > .03$ and no Bias X Cause interaction, $F(1, 14) = 2.17$, $p > .03$. See Figure 6.

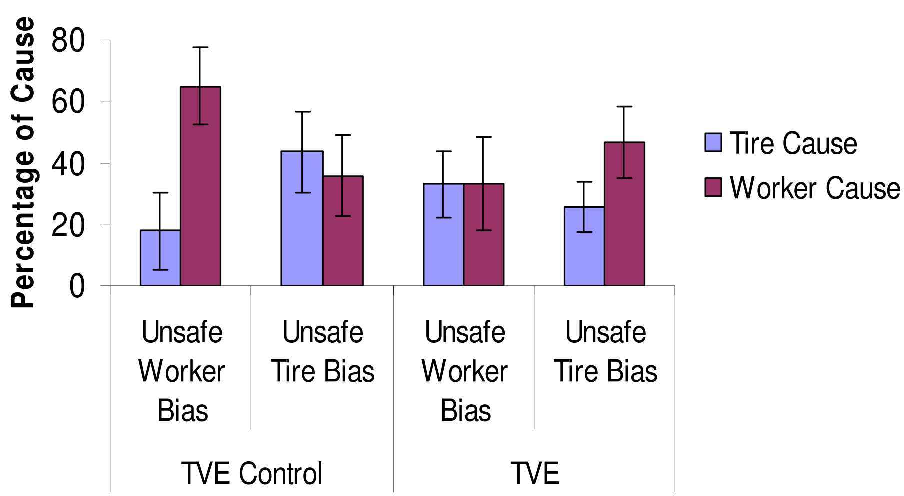

Figure 6. Professional-investigator: Cause allocation, bias and education. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

Confidence in Cause Allocation

After allocating cause for the event participants indicated their confidence in their cause allocation. Once again scatterplots revealed no consistent relationship between participants' allocation of cause and their level of confidence. Thus, I conducted a mixed-factorial ANOVA employing the between-subjects variables education and bias and the within-subjects variable time of confidence in cause allocation (confidence Time 1 or confidence Time 2).

Results revealed a significant Time X Bias X Education interaction [$F(1, 35) = 5.32$, $p < .03$, partial $\text{Eta}^2 = 0.13$] and no significant main effects for time, education or bias [*F's* (1, 135) < 1.80, *p*'s > .03]. Follow-up analyses explored participants' reporting at Time 1 and then at Time 2. Findings reveal that the Bias X Education interaction approached significance at Time 2 [$F(1, 35) = 3.90$, $p = .06$, partial $\text{Eta}^2 = 0.10$] but not at Time 1 [$F(1, 35) < 1$]. At Time 2 participants with an unsafe worker bias reported significantly higher confidence if they were in TVE control (*M* = 82.50, *SD* = 18.65) than those who were in TVE [*M* = 48.33, *SD* = 39.20; $F(1, 16) = 6.49$, $p < .03$, partial $\text{Eta}^2 = 0.29$]. In contrast, education did not result in participants with an unsafe tire bias significantly varying in the confidence they reported at Time 2 [*M* = 72.86, *SD* = 25.13; $F(1, 19) < 1$].

Seek Additional Information?

At both Time 1 and 2 professional-investigators indicated if they required more information to conclude the cause of the incident (7 = information is slightly adequate, some more information is needed; 5 = information is somewhat adequate, a little more information is needed; 3 = information is mostly adequate, more information would be nice but it is not needed). A mixed factorial ANOVA tested the between-subjects variables of bias and education and the within-subjects variables of time (satisfaction with the evidence at Time 1or satisfaction with the evidence at Time 2).

Results revealed a main effect of the within-subjects variable time, $F(1, 35) = 9.14$, $p < .01$, partial $Eta^2 = 0.21$. Investigators required more information at Time 1 ($M = 7.00$, $SD = 2.58$) than at Time 2 ($M = 5.44$, $SD = 2.73$). There was also a main effect of the between-subjects variable education [$F(1, 35) = 5.55$, $p < .03$, partial $Eta^2 = 0.14$]. On average, the Likert responses of participants who received the TVE intervention indicated that they required more information to conclude what happened ($M = 7.25$, $SD = 2.34$) whereas, those in TVE control selected that they required only a little more information to determine incident cause ($M = 5.50$, $SD = 2.66$).

What Information was Sought?

A mixed factorial ANOVA tested the between-subjects variables of bias and education and the within-subjects variables of information sought (information regarding the worker versus the tire) and time (Time 1 or Time 2). Results reveal a significant Bias X Education X Information Sought X Time interaction, $F(1, 28) = 5.48$, p < .03, partial $Eta^2 = 0.16$. No follow-up analyses were done to explore this 4 way interaction due to the variable sample sizes of the four between-subjects conditions: unsafe worker bias/ TVE, $n = 4$; unsafe worker bias/ TVE control, $n = 8$; unsafe tire bias/TVE, $n = 10$; and unsafe tire bias/ TVE control, $n = 11$. No other significant multivariate main effects or interactions were found for this analysis [F's $(1, 28) \leq 2.23$, p's $> .03$]. Results reveal that professional-investigators sought a relatively uniform amount of information about the worker ($M = 34.91$, $SD = 16.84$), tire ($M = 33.85$, $SD = 20.73$) and “other” ($M = 22,65$, $SD = 16.91$),.

Additional Evidence

Professional-investigators received 2 new pieces of information after completing their initial ratings of their investigative findings; one piece suggested worker fault and the other tire fault. Investigators rated how supportive this new evidence was to their original hypothesis of what caused the incident (5 = neutral; information did not support or discount what I originally determined, and 7 = supportive; information mostly reinforced what I had originally determined). A mixed factorial ANOVA tested the between-subjects variables of bias and education and the within-subjects variable of evidence support (evidence of worker fault or evidence of tire fault). Findings demonstrate no significant main effects or interactions, F's(1, 35) < 1. Overall, subjects found both the evidence that suggested worker fault (M = 6.10, SD = 1.59) and suggested tire fault (M = 6.15, SD = 1.37) as slightly supportive of their hypothesis of what caused the event (just as undergraduates in Study 1 did).

Interpretations of Investigative Behaviour

As in Study 2, I asked participants if and how prior knowledge influenced their investigation. Participants were asked how the unsafe worker or unsafe tire safety report provided to them at the outset of the study influenced: i) their allocation of cause for the event, ii) the amount of additional information they required to determine what happened, iii) the content of that additional information, and iv) their interpretation of the additional evidence. An "influence" variable was created that represented participants' average scores on the four 9-point Likert scales (3 = slightly influenced, 5 = somewhat influenced and 7 = highly influenced).

Results of the univariate ANOVA revealed an effect of bias that approached significance [$F(1, 35) = 3.25$, $p = .08$, partial $\text{Eta}^2 = 0.08$] that was consistent with the undergraduate-investigators' results. Participants in the unsafe tire bias condition reported that the unsafe safety report was more influential (M = 4.11, SD = 1.60) than those with an unsafe worker bias (M = 3.15, SD = 2.02). Findings also revealed that although non-significant, the effect of TVE approached significance [$F(1, 35) = 4.05$, $p = .05$, partial $Eta^2 = 0.10$]. Participants who had received the TVE intervention felt that they were less influenced by the unsafe safety report ($M = 3.05$, $SD = 1.53$) than those in TVE control ($M = 4.10$, $SD = 1.95$).

Participants who reported that the unsafe safety report influenced their investigation also reported *how* the unsafe report influenced their reporting (ranging from "benefited the investigation" to "hindered the investigation"). Hence, following each of the four influence items discussed above, participants provided a benefit/hindrance rating that indicated how the unsafe information influenced them on a 9-point Likert scale (5 = moderately negative/ moderately positive and 7 = mostly positive). A "Benefit/Hindrance" variable was created that represented the mean of participants' four benefit/hindrance items. On average, professional-investigators indicated that the unsafe safety report slightly benefited their investigative judgments ($M = 5.88$, $SD = 1.61$)[19].

Discussion

Consistent with the findings from undergraduate-investigators in Study 2, Study 3 found that bias affected professional-investigators' behaviour, but that bias may be moderated by a tunnel vision education (TVE) intervention. My primary interest in Study 3 was to explore how professional-investigators differed from the undergraduate-investigators in Study 2. The findings of Study 3 revealed that compared to undergraduates, professionals demonstrated a greater sophistication in their investigative reporting. Specifically, professionals were more effective in their information seeking,

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[19] No further analyses were done on the benefit/hindrance variable. Two professional-investigators in the unsafe worker bias/ TVE condition failed to complete these final benefit/hindrance items. The loss of two participants in this condition resulted in an appreciably smaller sample size ($n = 4$) compared to the other conditions (unsafe worker bias/ TVE control, $n = 8$; unsafe tire bias/TVE, $n = 10$; unsafe tire bias/ TVE control, $n = 11$).

cause allocations, and conclusions about the influence of prior knowledge on their investigative actions. I acknowledge that comparing professionals to undergraduates is a cross-experiment comparison. Pilot testing with professionals led to subtle adjustments in the instructions given in Study 3 compared to Study 2. These adjustments ensured that professionals adopted the bias manipulation and only allocated cause to direct factors (such as the behaviour of undergraduate-investigators in Study 2). There are numerous similarities in the method and measures of Study 2 and Study 3 and I propose that these many similarities provide a stable foundation for comparison between undergraduate- and professional-investigators in the simulated investigation exercise. Thus, in the following discussion I examine the influence that bias and TVE had on professional-investigators' reporting, as well as highlight the notable similarities and differences between undergraduate and professional responding.

TVE intervention and considering alternatives. Before embarking on my discussion of the influence of bias and education on professional-investigators' reporting I once again analyse if the TVE intervention performed as anticipated. Similar to undergraduate-investigators I found that professionals who received TVE: (1) were aware of tunnel vision as they answered all of the tunnel vision quiz items accurately, (2) did not provide significantly more alternative hypotheses on the open-ended query about plausible cause(s) of the workplace event than control participants, and (3) allocated significantly more cause to "other" factors in their cause allocation (M = 30%) than those in control (M = 19%). This third finding suggests that TVE increased participants' consideration of factors beyond the tire and the worker as plausible contributors to the workplace event. However, my conclusion from these three findings mirrors my conclusion in Study 2. Namely, I see firm evidence that investigators were aware of tunnel vision and less support that TVE increased participants' consideration of alternatives.

Comparing the findings from Study 2 to Study 3 we see that professionals considered a greater number of more diverse hypotheses about the workplace event than undergraduates. Specifically, professionals produced more hypotheses about event cause on the open-ended question querying what caused the event (professionals $M = 2.94$; undergraduates $M = 1.86$). In addition, professionals produced more hypotheses about factors other than the tire or the worker on the open-ended question ($M = 2$; undergraduates $M = 1$) and they attributed a greater percentage of cause in their cause allocation to "other" factors (professionals $M = 23\%$; undergraduates $M = 9\%$).

Professionals' greater sophistication at considering alternatives may be associated with their investigative experience or may simply be a by-product of having tacit knowledge of an industrial environment. Phillips et al., (2007) stated that compared to novices, experts have a greater breadth and depth of domain-specific knowledge. Hence, years of experience may have provided professional-investigators with a personal metric of judging inculpating and exculpating evidence. Professionals' assessment of the information provided in the simulated investigation may have failed to meet their criteria of implicating evidence and thus, professionals may have been more willing to entertain alternatives. Additionally, professionals may have a greater contextual knowledge of an industrial worksite. This knowledge may have provided them with a number of readily available alternatives beyond the worker or tire cause when thinking about the event, alternatives that may not have been available to participants from the undergraduate population. Regardless of the root of this undergraduate/professional difference, professionals' propensity and ability to consider alternatives may have underscored their greater sophistication in undertaking the simulated investigation task. The sophistication of professional-investigators was demonstrated in the majority of the findings from Study 3. These findings are discussed below.

Cause allocation and the FAE. Study 2 and Study 3's findings suggested that both undergraduate- and professional-investigators, on average, allocated approximately half of the cause for the incident to the worker. The other half of their cause allocations were divided between the tire and other factors. The evidence I provided in the simulated investigation delivered an equal amount of responsibility to the tire and the worker for the workplace event. Therefore, objective assessment of the evidence should have led participants to conclude equal culpability for the tire and the worker. Hence, the findings of Study 2 and 3 demonstrated that both undergraduate and professional-investigators had a general preference to allocate cause to human error.

Cause allocation, bias and education. The findings from Study 2 and Study 3 consistently demonstrated that bias and education influenced participants' cause allocations. Although similar in a number of ways, professionals did show some variation from undergraduates in how they allocated cause for the event. For instance, in Study 2 the effect of the unsafe worker or unsafe tire bias was similar on undergraduate-investigators' cause allocations at both Time 1 and at Time 2 (for those in TVE control) and education only affected participants' cause allocations at Time 2. In contrast, professional-investigators' cause allocations varied from Time 1 to Time 2 based on their bias condition and they responded immediately (Time 1) to the TVE intervention. Below is a discussion of these results in greater detail.

Cause allocation and bias. Professional-investigators with an unsafe worker bias as well as those with an unsafe tire bias varied in their ratings of cause from Time 1 to

Time 2. At Time 1, professional-investigators with an unsafe worker bias allocated a greater percentage of cause to the worker compared to the tire. Professionals with an unsafe tire bias did not differ in the amount of cause they allocated to the tire and worker. Recall that in Study 2 I proposed that those with an unsafe worker bias are prone to conclude human error because of a possible alignment between the unsafe worker information and the FAE. In contrast, participants in the unsafe tire bias condition may not differ in their cause allocation because they may be entertaining two biases that suggest both worker cause (FAE) and tire cause (unsafe tire information). How professionals' allocated cause at Time 1 further supports this conclusion from Study 2.

Professional-investigators' Time 2 cause allocations significantly differed from their Time 1 responses. At Time 2, participants with unsafe worker and tire biases attributed more cause to the worker compared to the tire or "other." Professionals' Time 2 results suggested that the FAE may have produced a governing effect on professionals' final cause allocations that resulted in a general tendency to allocate cause to human error.

Cause allocation and additional evidence. Just prior to giving their Time 2 cause allocation, participants considered two pieces of evidence (one supportive of worker fault the other of tire fault). The literature on confirmation bias states that people interpret information to be consistent with their preconceived ideas (Nickerson, 1998). Participants demonstrated this characteristic of confirmation bias as both undergraduate- and professional-investigators in the TVE control condition rated both pieces of additional evidence as slightly supportive of their hypothesis of what caused the workplace event regardless of their bias.

Interestingly, after receiving the additional evidence all participants allocated more cause to the worker than the tire. This finding is expected for those in the unsafe worker bias condition but unexpected from those participants who received unsafe tire information. If participants with an unsafe tire bias were in fact harbouring dual biases (unsafe worker and tire) the theory of confirmation bias would predict that the additional evidence would have led these participants to allocate more cause to the tire *and* the worker at Time 2, but this was not the case. Hence, the result that those who received unsafe tire information allocated a greater percentage of cause to the worker than the tire at Time 2 may be evidence for the strength of the FAE in human reasoning. As the investigation progressed the FAE seemed to emerge as a guiding influence on professional-investigators' reasoning.

Both professional- and undergraduate-investigators interpreted the additional evidence as slightly supportive of their hypothesis of what caused the event, but professionals demonstrated greater skill in their use of the additional information. Receiving the additional evidence led undergraduates to allocate a slightly greater percentage of cause to the tire and worker at Time 2 than Time 1 as well as to report higher confidence in their cause allocation at Time 2 compared to time 1. Professionals were more measured in their use of the additional information. From Time 1 to Time 2 professionals did not change the amount of cause allocated to the tire and worker nor did their confidence increase. Again, the sophistication demonstrated by professionals in their use of the additional information may stem from experience. Although professionals rated the additional evidence as supportive of their theory of event cause they may not have interpreted the information as highly inculpatory.

Cause allocation and education. One of the most notable differences between the reporting of undergraduates and professionals was the rate at which their cause allocations responded to the education intervention. Both undergraduates and professionals allocated cause in a similar fashion when they received the TVE intervention, but professionals responded immediately at Time 1, whereas, education only influenced undergraduates at Time 2. Similar to undergraduates, professional-investigators in TVE control with an unsafe worker bias allocated significantly more cause to the worker than to the tire and TVE participants with an unsafe worker bias allocated a consistent amount of cause to both the tire and the worker. Professional-investigators in TVE and TVE control with an unsafe tire bias did not significantly differ in their cause allocation. Interestingly, although not statistically significant, professional-investigators who received the TVE intervention with an unsafe tire bias had a tendency to allocated more cause to the worker than the tire, a finding that was statistically significant at Time 2 for undergraduate-investigators.

Of central interest is why professionals responded faster to the intervention than undergraduates. Glaser (1996) described the changes that may occur in personal judgment once expertise is developed. Specifically, the variable and awkward performance of novices evolves into the more consistent and efficient behaviour of the expert. The findings from Study 3 seem to suggest that indeed professionals were behaving with greater consistency and efficiency; professionals were ultimately faster at identifying the purpose and use of the TVE intervention than undergraduates.

Information seeking. The findings from Study 2 and Study 3 suggest that both education and expertise positively affected participants' information seeking. The information provided to participants in the simulated investigation was not sufficient to render a firm conclusion about what caused the industrial incident. Positively, both undergraduate- and professional-investigators indicated that they required more information to conclude what caused the event at both Time 1 and Time 2. In addition, TVE led both undergraduate- and professional-investigators to seek a greater amount of information to render a conclusion as to the cause(s) of the event than those in control. Importantly, professionals at both time points and in both education conditions reported that they were less satisfied with the information and hence required more evidence than undergraduates.

When asked what information they required, I found that neither time, education, nor bias influenced the type of information professional-investigators sought. Professionals requested an even amount of information about the tire, worker and "other." Undergraduates were not as consistent in their information seeking and at Time 1 they sought information about both the tire and the worker, whereas at Time 2 they sought largely worker information. Hence, the findings of Study 3 suggest that professionals were more effective at information seeking than undergraduates. I speculate that it was professionals' experience in investigation that led to the information seeking findings of Study 3. I submitted previously that professionals' experience in investigations may provide them with criteria for what constitutes inculpating information. The sparse amount of ambiguous information provided to them in the simulated investigation may not have met their criteria. Hence, this lack of substantive evidence may have led professionals to request a greater amount of information from all subject categories (worker, tire and other).

Influence. Participant-investigators in Study 2 and Study 3 were asked if the safety report information provided to them at the outset of the experiment influenced their allocation of cause, information seeking, and their interpretation of addition information. Undergraduate-investigators with an unsafe tire bias felt that they were more influenced by the unsafe safety report than those with an unsafe worker bias. A finding that approached significance suggested this same pattern of results for professional-investigators. As discussed in Study 2, I suspect that the saliency of the unsafe tire information, saliency produced because it is inconsistent with participants' natural human error bias (FAE), led participants to conclude that it had a greater influence on their behaviour than those receiving unsafe worker information. Like undergraduate-investigators, professional-investigators indicated that the unsafe information slightly helped their investigation, a findings that is consistent with people's predisposition to interpret prior knowledge as insightful rather than biasing (Ehrlinger, 2005).

TVE affected professional-investigators' reporting about the influence of the unsafe safety report on their investigative judgments, but the same intervention did not affect undergraduates' reporting. Although almost all undergraduate- and professional-investigators indicated that the safety report information influenced their investigative behaviours, the findings of Study 3 revealed that professional-investigators who were in TVE control reported that they were more influenced by the safety report than TVE professionals. It is true that professionals' cause allocations were more influenced by the unsafe information when they were in the TVE control rather than TVE condition. However, education did not affect what information professional-investigators sought or their interpretation of the additional evidence. Further, when professionals were asked how the safety report influenced them, they reported that it slightly helped their investigation. The results from Study 3 demonstrate that the true influence of the safety report on professional-investigators' judgments was to bias them. These results illustrate that participants were in fact unreliable judges of how the prior knowledge of the worker or tire influenced their decision making.

Comparing Study 2 and Study 3's influence variables we find that undergraduates felt that they were more influenced by the unsafe safety report than professional investigators. Indeed, it seems that professionals were less influenced by the unsafe information provided to them at the beginning of the experiment than undergraduate-investigators. It might be that participants produced reliable (but not valid) assessments of how much this prior knowledge influenced their investigative judgments. I suspect that the root of this undergraduate –professional difference is that professional-investigators, having years of experience, have a self-concept that they are objective at weighing information. Because an unsafe history is not a strong piece of evidence implicating fault they may conclude that they were not overly influenced by it. Undergraduates, not entirely aware of what constitutes strong evidence, may be more willing to admit that the unsafe information influenced their investigative behaviours.

To conclude, the findings from Study 3 illustrated that the pattern of results produced by professional-investigators in the simulated investigation was very similar to undergraduate-investigators'. Bias influenced participants' allocation of cause and TVE proved effective at moderating the influence of bias. It is important to note, however, that investigative experience did result in some variation in participant responding. Professionals sought a greater amount of additional information and sought a consistent amount of information from all the available categories. Professionals also allocated a greater percentage of cause to "other" factors. Additionally, professionals identified the utility of the TVE intervention faster than undergraduates and incorporated its teachings sooner into their decision making process. These variations in reporting between undergraduate- and professional-investigators demonstrate that professionals were more effective at the simulated industrial investigation than undergraduate-investigators.

GENERAL DISCUSSION

This dissertation research was predicated on three findings from the literature on human bias in decision-making. First, tunnel vision can lead to biased investigative conclusions (Findley & Scott, 2006). Second, when people suspect bias in their judgments, their debiasing efforts tend to be theory driven (Wegener & Petty, 1995). That is, people correct for the bias they believe that they have and their debiasing efforts may or may not be effective. Third, asking people to consider-alternatives can facilitate objective decision making (Hirt & Markman, 1995). These three findings established the foundation for this dissertation.

Rating the Influence of Prior Knowledge

Study 1 revealed that professional-investigators usually have a great deal of knowledge about the worker(s), equipment, and job position(s) involved in the industrial event before they begin their investigations. Investigators indicated that they perceive this information as largely beneficial when collecting and interpreting information but mostly unhelpful in their investigative decision making. Investigators deducing that contextual knowledge is largely insightful may be more willing to actively employ a priori information when seeking and interpreting information. Hence, contextual knowledge may guide and expedite evidence collection, evidence interpretation, and subsequently, decision making. The guidance provided by prior knowledge may facilitate the investigation when the information provides insight on the current event and hinder the investigation when the information provides a source of bias.

Studies 2 and 3 tested if participants reported that prior knowledge was useful when it introduced bias into their industrial investigations rather than insight. Nearly all participants reported that the unsafe information about the worker or the tire benefited their investigation when in fact the information biased their conclusions. This finding is consistent with previous research demonstrating that people typically believe that personal connection to an issue provides them with greater insight rather than bias (Ehrlinger et al., 2005).

Predictably, participants in the TVE control condition employed the “helpful” unsafe tire and worker information when they derived their allocations of cause for the event. Interestingly, however, participants who received the TVE intervention maintained that the unsafe safety report was influential and beneficial in their investigation even though they took measures to control for its influence when they allocated cause for the event. This pattern of results fits with my prediction that TVE participants may correct for the bias they believe the unsafe safety report produced, and subsequently conclude that the residual influence of the unsafe background information was beneficial. The findings of this dissertation illustrate people’s robust tendency to view a priori information as useful even if participants acknowledge and correct for any bias generated from it.

Investigative Judgments

Studies 2 and 3 explored investigative tunnel vision by testing *how* a priori information about a worker’s or tire’s safety, that provided no functional benefit in establishing what caused the industrial incident, directed investigators’ investigative judgments. Prior knowledge guided cause allocation by directing investigators to allocate more cause to the factor they believed had an unsafe history. Tunnel vision was also evident in participants’ interpretations of additional evidence as both pieces of information (one supportive of worker fault and one supporting tire fault) were viewed as supporting their hypothesis of what caused the incident.

Interestingly, undergraduate- and professional-investigators demonstrated an overall preference to allocate cause to the worker. This finding is consistent with the literature on the FAE and discussions of the correspondence bias. Participants' propensity to indicate worker cause should be of special interest to the occupational health and safety community. The industrial investigation literature estimates that 70% of all incidents are a direct function of human error (Dekker, 2006). Putting aside the issue of what is the underlying or root cause(s) of an incident, we see that the fundamental attribution error (FAE) may be an efficient bias for industrial investigators who are establishing an incident's direct cause(s). Tunnel vision based on a human error bias could save time and resources as a conclusion of worker fault should be statistically accurate the majority of the time. Of course, the more pragmatic way to view this human error tendency is with caution. Statistics about incident cause are most probably compiled from incident reports produced by industrial investigators. Hence the presence of the FAE in this industrial investigation exercise conjures the "chicken-or-the-egg" conundrum; is it human error bias driving the conclusions of 70% worker fault? or is chronic worker fault reinforcing investigators' human error bias? Future research employing a control condition in the bias manipulation would be helpful to gaining better understanding of the strength of the FAE in industrial investigation decision making.

The FAE in the context of industrial accident investigation. Sabini, Siepmann, and Stein, 2001.'s (2001) evaluation of how psychological research has conceptualized internal (dispositional) and external (situational) factors proposed that this is a crude dichotomy and it is not sufficient to explain the nuances of the findings of the seminal research on the FAE. They suggested that people judging others' behaviour underestimate the demand of the situational variable "saving face" and we need to expand our understanding of situational constraints to include these less visible factors. This dissertation research asked participants to allocate cause to direct factors of the workplace event (i.e., worker, equipment, environment, and process) and found that investigators attributed more cause to the worker than situational variables (tire, environment, process). This is a crude measure of the FAE; by asking participants to allocate cause to only direct causes I asked them if the worker or other situational variables caused the *incident* I did not provide them with the opportunity to demonstrate if or what situational variables influenced the *worker's behaviour.* Thus, the findings of this research do not unearth if investigators considered less visible situational constraints on the worker such as lack of training, production pressure, or poor supervision. This is a limitation of the research as asking for a more complex allocation of cause may illuminate that investigators were considering more situational factors than what was captured in the present study. Hence, future research should expand its exploration of cause allocation to capture a more nuanced picture of how investigators allocate cause for an event.

The findings from Studies 2 and 3 also demonstrated that tunnel vision may be moderated by a TVE intervention and that the influence of TVE on participant reporting varied with participant bias (unsafe worker or tire). It is possible that the root source of this variation between bias conditions is in how participants used the TVE intervention. Findings from Study 2 and Study 3 suggested that TVE increased awareness of tunnel vision but it may not have resulted in participants considering more alternative hypotheses. The awareness generated by TVE led participant-investigators to generally correct for the bias they were aware of (unsafe worker or tire) but not the more subtle bias of the FAE, a result that is consistent with findings from the warning literature (Stapel et al., 1998) and literature on the correspondence bias (Croxton & Miller, 1987; Hilton, et al. 1993).

Future research could expand current understanding of the FAE in industrial investigation by exploring if participants in fact consider situational factors as causes of the *worker's actions*. If findings reveal a general failure to consider situational factors, additional research could tackle developing investigator education programs designed to facilitate their use of "consider alternatives" strategies as they generate hypotheses about incident cause.

A natural next step for follow up research to the current study is to explore the limits of TVE. The current research biased participants' reporting by providing them with information about either an unsafe worker or an unsafe tire. Careful consideration of this information reveals that participants may have been able to self-generate many ways in which a worker could be culpable for a workplace event and fewer ways in which the tire could be culpable. To better understand the true impact of TVE future research may wish to provide participants with unsafe and neutral information about two workers or two tires and measure how TVE influences decision making based on these stimuli. This type of design would allow for a more fine grained analysis of the impact of the TVE intervention.

We can infer the value that considering alternatives contributes to the investigation by comparing professional- to undergraduate-investigator reporting. Professional-investigators considered more alternatives about event cause than undergraduate-investigators and I propose that it was professionals' consideration of more alternatives that facilitated their superior performance in the simulated investigation (e.g., allocated more cause to factors other than the tire and the worker, more balanced in their confidence ratings and information seeking activities). Hence, future research should focus on facilitating participants' ability to run mental simulations of what could have caused the industrial event.

One method by which participants' ability to consider alternatives could be improved is by enhancing the TVE intervention. For instance, participants could be asked to practice generating alternatives in a training exercise before beginning the true investigation. Alternatively, participants could pair the TVE intervention with one of the protocols that are currently being used in applied settings. For instance participants could employ Cohen et al.'s (1998) "crystal ball" methodology to develop alternative hypotheses based on the available evidence. Participants could also use Stubbins and Stubbins' (2009) four-step consider alternatives protocol or Heuer's (1999) eight-step ACH procedure to enhance the rigor in which they consider alternative causes for the adverse industrial event. Additionally, standardized investigation protocols already in practice in some industrial workplaces could potentially enhance people's consideration of alternatives. For instance, DNV's Systematic Cause Analysis Technique (SCAT) uses a structured investigation chart by which investigators actively consider, and select from, a number of alternatives when rendering their investigative decisions. By coupling the TVE intervention with SCAT we may increase the rigor with which investigators consider alternatives.

Future research should also increase the complexity of the industrial investigation exercise by providing participants with a larger bank of evidence about the incident. Providing participants with a greater breadth of information may facilitate a broader understanding of the factors involved in the incident and improve participants' ability to run mental simulations of event cause. In addition, a more complex investigative scenario may highlight the nuances of how novice (undergraduate) and professional-investigators respond to a TVE intervention. Stubbins and Stubbins (2009) stated that expert investigators are more able to distinguish the relevant and significant information from the irrelevant, are not as overwhelmed by the data, and their intuitions "come more readily and are more complex" (p. 105) than novice investigators'. The advantage that experience affords was indicated by professional-investigators' responses in Study 3. The findings from Study 2 and Study 3 demonstrated that combining investigative experience and TVE produced the most sophisticated judgments in the simulated investigation. Primarily, professionals who received the TVE intervention generated allocations of incident cause that demonstrated the least amount of bias. In addition, experience facilitated participants' responding by allowing professionals to: respond faster to the TVE intervention than undergraduates, require more information to conclude what caused the event, and be more consistent in the content of the information they sought. Recall that I previously proposed that experience may inform professionals about the characteristics of inculpating and exculpating evidence, as well as equip them with a greater breath of readily accessible, plausible alternatives when generating hypotheses about what caused the event. Hence, increasing the complexity of the simulated investigation should provide further room to explore the similarities and differences of how novices and professionals incorporate a TVE intervention.

This dissertation research demonstrated how preconceived opinions and the FAE guided early hypothesis generation, and then showed how confirmation bias propelled prejudices through the investigation. The occupational health and safety literature

[Dekker, 2006; Reason, 1990; Workers' Compensation Board of BC (WCB), 1998] and the legal literature (Findley & Scott, 2006; Rossmo, 2009) have identified a number of heuristics and biases that can influence the generation of hypotheses about an event and the behaviours associated with tunnel vision. Heuristics such as the representative heuristic and the availability heuristic, as well as biases like confirmation bias, hindsight bias, and outcome bias can all play a part in the progression of distorted decision making. Adding to the complexity of investigative bias are factors external to individual cognitive processes that can guide hypothesis formation and the subsequent investigation. Factors such as an organizational culture of decisiveness, or time, financial or managerial pressures may all lead to hasty conclusions about incident cause. To illustrate, when asked about factors that influence his investigation, one industrial investigator stated "It is easy to come to a conclusion before you have done the investigation…superiors may want a certain outcome based upon their own prejudices" (Personal communication, MacLean, Brimacombe, & Stinson, 2006). Hence, factors that lead to biased investigative conclusions are multifaceted and are a product of interactions between an investigator's internal cognitive processes and the external environment. Thus, this research illuminates but a corner of the vast and complex issue of distorted investigative decision making.

Conclusion

Over the last 50 years, the phenomenon of confirmation bias has been researched in a multitude of domains, such as rule generation (Wason, 1960) and social beliefs and stereotypes (e.g., Snyder & Swann, 1978). In a legal realm, confirmation bias has been explored in relation to jurors (Hendry, Shaffer, & Peacock, 1989), criminal investigators (Meissner & Kassin, 2002), forensic scientists (Risinger, Saks, Thompson, & Rosenthal,

2002) and finger print examiners more specifically (Dror & Charlton, 2006; Dror et al., 2006; Dror, Peron, Hind, & Charlton, 2005).

People's tendency to seek and interpret information consistent with their preconceived ideas was studied in research considering the investigator bias effect (IBE) in criminal investigative interviewing (e.g., Kassin, Goldstein, & Savitsky, 2001). The IBE is the phenomena that although police officers are no more accurate than non-officers at discriminating between truthful and deceptive statements (e.g., DePaulo, 1994; Garrido, Masip, & Herrero, 2004), they are more likely to judge suspect statements as deceptive (Meissner & Kassin, 2002). Meissner and Kassin (2004) demonstrated the affect of the IBE in the criminal investigative interview as their participants' actively sought information that was consistent with their hypothesis of suspect guilt (e.g., coercive interrogation techniques).

Additionally, a series of studies by Dror, Charlton and colleagues demonstrated the influence of contextual knowledge on finger print analysis (Dror & Charlton, 2006; Dror et al., 2006; Dror et al., 2005). Undergraduate-participants provided with highly emotional stories were significantly more likely to judge ambiguous finger prints as a match to finger prints taken from a suspect than those who were provided with stories low in emotional content (Dror et al., 2005). These findings from the criminal investigation literature demonstrate the powerful effects that contextual information can have on both lay and expert opinion.

I would like to be clear that by pursuing this research I am in no way making a value judgment about the cognitive abilities of industrial investigation professionals. These biases and distortions are natural tendencies that can, and do, influence anyone's collection and interpretation of information. Excitingly, this dissertation research suggests that interventions such as tunnel vision education may benefit decision makers. Further, there is a wave of interest and study concerning investigative bias and decision making (e.g., Ask & Granhag, 2005; Boyce, Lindsay, & Brimacombe, 2008; Dahl et al., 2009; Kerstholt & Eikelboom, 2007; Lindsay, et al., 2000; MacLean et al., accepted for publication pending revisions; Meissner & Kassin, 2004; Ormerod, 2009).

What I hope to contribute by being part of this groundswell of research are interventions aimed at minimizing bias in the investigative process. Biases can cloud investigators' abilities to objectively assess evidence and it is only through thorough and effective industrial investigations that investigators will uncover the appropriate interventions to prevent similar industrial events in the future.

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APPENDIX A

Investigators Categorized by Organization Type

Industry	Organization	Frequency	Percent
Regulatory		17	9
Training		1	0.5
Primary Resources	Agriculture	1	0.5
	Fishing	3	2
	Forestry		
	Oil and Gas	25	13*
	Mineral Resources	3	2
Manufacturing	Food and Beverage Products	2	1
	Metal and Non-metallic Mineral Products	8	4
	Petroleum, Coal, Rubber, Plastic and Chemical Products	7	4
	Wood and Paper Products	19	10*
	Other Products	16	9
Construction	General Construction	9	5
	Heavy Construction	12	7
	Road Construction or Maintenance	3	2
Transportation and Warehousing	Warehousing	2	1
	Transportation and Related Services	7	4
Trade	Retail	1	0.5
	Wholesale		
Public Sector	Public Administration	9	5
Service Sector	Accommodation, Leisure, and Food Services	2	1
	Business Services		
	Professional, Scientific, and Technical Services	11	6
	Other Services	2	1
	Education	6	3
	Health care and Social Assistance	7	4
	Utilities	12	7

Note: N = 185, * Industries representing 10% or more of the sample

APPENDIX B

The Influence of Prior knowledge: Information Seeking, Interpretation of New Information and Decision Making

Key

Text:
Pink = Major influence, Black = Minor influence

Highlight

Yellow highlight:	Objectivity
Grey highlight:	Information collection
Aqua highlight:	Interpretation of new information
Green highlight:	Decision making
Blue highlighting:	Redundant: the investigator has said the same thing in a previous statement, elaborations are considered redundancies. Thus, something new/different related to the category has to be included to be counted as a unique piece of information.
*	Investigator has made a second statement that is different than the first which also fits in the indicated category.

Main category (i.e. positive, negative, no effect and acknowledgement) the n = the number of investigators out of the 110 that responded to at least 1 of the 4 questions who made a statement that fit in the category.

The main subcategories (i.e. objectivity, information collection, interpretation of new info, and decision making) will capture all the unique statements made by the investigators that fit into those categories, total n = all the unique statements made by the investigators

110 = total number of investigators responding to at least 1 of the 4 open-ended questions
371 = Pieces of unique information which were categorized into information collection, interpretation of new information, decision making and objectivity.

To obtain this number the total number of statements for the objectivity, decision making, interpretation of new information and info seeking was added from the no effect and effect (ambiguous, positive, & negative) categories.

No effect: 20 + 8 + 8 = 36
Effect Ambiguous: 15 +2 + 17 + 13 = 47
Effect Positive : 91+68+3+12 = 174
Effect Negative: 20+36+39+19 = 114

Please note that objectivity was included in the scoring process. This was not discussed in the findings from Study 1.

No Effect of Prior Knowledge

	Participant Number													
	12-30	31-50	51-70	71-90	91-110	111-130	131-150	151-170	171-190	191-210	211-230	231-250	251-270	**Total Number of invest. /110**
No Effect	12, 22, 18, 26 25, 23 32		59	72, 80, 90, 75, 86, 95	109		143,	163, 170, 167	174, 182, 183, 190	195, 205, 203, 203		242		27/110
1. *Objectivity:* Prior knowledge has no effect on investigative objectivity. (the facts are the facts) **(O)**	18, 25, 26, 23, 32, 12, 22, 26**		59	75, 95				163, 170, 167	182, 183, 190	203, 205, 205*				18/110
2. *Information collection*: Prior knowledge has no effect on information collection.	32 26*			75				163, 167	190	195		242		8/ 110
3. Decision Making: Prior Knowledge does	22, 26**			86, 75*,	109				174	203				9/110

not influence investigative conclusions.				80, 90										

Effect of Prior Knowledge: Ambiguous

	12-30	31-50	51-70	71-90	91-110	111-130	131-150	151-170	171-190	191-210	211-230	231-250	251-270		**Total /number of investigators**
Ambiguous: Prior knowledge influences the investigation. Investigator does not indicate if this is positive or negative.	12, 13, 18	32, 35,	52, 54, 69, 58, 55	79, 85, 83	108, 103, 105,	113, 118, 116, 122, 119	143,	153, 161, 169	181, 184, 187	205	222, 223, 225, 212	238, 239, 248, 237, 247		**total # of unique statements**	38/110
1. *Information collection:* influences information collection e.g., guides what is focused on.	12	35	52, 52*, 69, 58	85	108	119, 113			184		212, 212*	238, 239		15	13/110
i) What information is sought:	12				108									2	
a) Content: Prior knowledge guides investigators in the information they are looking for.	12				108									2	
ii) How information is sought:			52, 52*,								212, 212*			4	
a) Questioning: Prior knowledge guides what questions are asked.			52, 52*,								212			3	

b) Order: Prior knowledge influences the order in which information is collected.											212*			1	
iii) Information source						113			184					2	
a) Interviewee information: Knowledge influences workers recollection for the event.						113			184					2	
2. *Interpretation of Information:* Prior knowledge may guide the interpretation of information.										205		248		2	2/110
3. *Decision making* Prior information influences investigative decision making (investigator may state they are resistant to its influence) Decision making: Recommendations of what happened.	13, 18	32	54, 69, 54*	83	105,	116, 118,		161,			222, 225			13	12/11 0
4. *Objectivity:* Investigator states that they attempt to stay as objective as possible and/or do not succumb to bias in the investigation (i.e. they are resistant to influence).			52, 69, 55, 69	79,		113, 118		153, 161	181, 181,, 187		223, 225	237, 247, 238, 248		17	17/11 0

Effect of Prior Knowledge: Positive

	12-30	31-50	51-70	71-90	91-110	111-130	131-150	151-170	171-190	191-210	211-230	231-250	251-270		**Total /number of investigators**
Positive: Prior knowledge benefits the collection and interpretation of information, as well as, investigative decision making and objectivity.	12, 22, 24, 17, 24, 23, 18 17, 18, 22, 24, 24	35, 45, 50, 32, 47, 35, 32, 42, 47, 50 , 46, 47, 50	57, 59 68, 54, 55, 57, 55, 54, 57, 68 , 55, 57, 68	76, 86, 90, 79, 80, 84, 76, 79, 83, 90, 76	102, 103, 106, 109, 97, 97, 109	113, 118, 125, 116, 113, 118, 119, 125, 113, 118, 125	143, 148, 136, 145, 139, 145, 139, 148	151, 170, 153, 167, 153, 167, 170, 151, 167 170	174, 184, 189, 190, 173, 187, 182, 173, 174, 189, 173	209, 203, 205, 203, 209, 207, 209	214, 225, 221, 225, 221, 222, 221, 225	236, 238, 242, 238, 242, 236	253 264 257 253 259 264 257		66/110
														/total # of unique statements	
1. *Information collection:* Positively influences information collection.	18, 18*, 23, 23*, 22, 22*, 24	42, 45, 35, 35*, 47, 47*, 47**, 50, 32, 32*,	54, 54*, 55, 57, 57*,	76, 76*, 76**, 76***, 76****, 76*****, 76**	106, 106*, 97,	118*, 113, 125, 125*, 118, 118**, 118***,	145, 145*, 136, 139,	151, 151*, 151**, 153, 153*, 170, 170*, 170**,	182, 182*, 187, 189, 174, 184, 174*, 184*,	205, 209, 203,	221, 221*, 225, 225*	236, 236*, 242, 238,	257, 253, 259	91	47/110

		50*, 50**, 50***,, 46, 46*, 50		**** 79, 79*, 90, 84, 84*, 84**, 86,				170*** 170***, 170****, 151, 167, 167*,							
i) What information is sought:	23	45, 47, 50, 32, 50* 47*, 46, 50	54, 57, 57	76***, 79, 90, 84		118, 125, 118, 125*	148, 136	151, 153, 170, 151		209, 203,	221, 225	236, 242		28	
a) Content: Prior knowledge guides investigators in the content of what should be collected. (e.g., informs them as to what is the normal state so they can seek the differences, or guides them in the collection of specific information)	23	45, 47, 50, 32, 50* 47*, 46, 50	54, 57, 57	79, 90, 84		118, 125, 118, 125*	148, 136	151, 153, 170, 151		209, 203,	221, 225	236, 242		27	
ii) How information is sought:	18, 18*, 22, 22*,	35, 47**, 32*, 50**, 46*, 47***, 42,	55	76***, 76****, 76*****, 76******, 86, 84*, 76, 79*,	106, 106*,	118*, 113, 118**	145, 145*, 139	151*, 167, 151, 170, 170**, 153, 170, 170***	174, 184, 182, 174*, 184*, 182*		225*	238, 236*	253, 257, 259	48	

				84**											
a) Thoroughness: Having or lacking prior information leads to a <u>more</u> thorough investigation.		46*, 50**		76**, 86, 84*	106	118*	145	151*, 167, 151, 170			225*	238	253	14	
<u>Having</u> prior knowledge encourages a more thorough investigation.				86, 84*	106			151* 167, 151, 170						6	
<u>Not having</u> knowledge encourages a more thorough investigation (guides an investigator to seek more information).		46*, 50**		76**,		118*						238	253	6	
b) Questioning: Knowledge increases the quality of interviewee questioning.	22, 18	47** *		76** **, 79*, 84**			145*	170* *, 153, 170	174, 184, 182					13	
c) Quality of information: Prior knowledge enhances the quality of the information obtained.	18*,	32*, 35		76** ***		113		170* **	174*, 184*, 182*					9	
d) Speed of evidence collection: Prior knowledge increases the speed of the investigation.		47**	55	76** ****	106*		139						257	6	
e) Timing: Knowledge informs at what point in the investigation an investigator should collect each type of information.	22*											236*		2	

f) Planning: Knowledge aids in the planning of an investigation						118* *							259	2	
iii) Source of Information	12, 23*	50** *, 35*			97	118* **		167*, 170* ***, 151* *,	187, 189		221*			12	
a) Location: Prior knowledge influences where the investigator looks for the information.	12, 23*	35*			97	118* **		167*, 170* ***, 151* *,	187, 189					10	
2. Interpretation of information: Prior knowledge enhances investigators ability to interpret incident information.	17, 22, 22*, 22** *, 24, 24*, 24, 17, 24	32, 32, 47, 50, 50,, 50 47*	55, 55*, 54, 57, 57*, 68, 68, 68, 68, 55,	76, 83, 80, 90, 90*	97, 106, 102, 103, 109, 109*,	113, 119, 116, 118, 125, 118	139, 145*. 145, 151, 148, 139*,	151, 170, 170*, 170* *, 170,* ** 167, 167*, 182, 189*	173, 174, 187, 189, 189* 190	203, 203, 209, 209, 207	214, 225, 221, 221*, 223, 222, 225, 221	236, 238, 238* , 242, 236*	253	68	49/11 0
i) Insight: Prior knowledge helps the investigator understand the information they are considering (clarity). A context for the information leading to potential options as to what may have happened.	22** *, 24*, 17, 24, 24, 17,, 24	32, 32, 47, 50, 50,, 50 47*	54, 55*, 55, 57, 68, 68, 68, 68, 55,	83, , 90, 90*	97, 106, 103, 109*,	113, 119, 116, 118, 118	145, 151, 148, 139*	151, 170, 170*, 170* *, 170,* ** 167, 167*, 182, 189	173, 189, 190, 189*	203, 207	214, 225, 221, 221*, 223, 225, 221	236, 238, 238* , 242, 236* ,	253	54	

ii) Provides a criterion: Prior knowledge provides investigators with threshold for inclusion or exclusion of information.	22*		57*,		102, 109	125	139, 145	189*	174	209	222			11	
3. Decision Making: Prior knowledge aids investigative decision making.	22		59	90, 76, 79		125	148	170	173	209, 209	221, 221		257	12	12/110
4. Objectivity: Prior knowledge aids investigators to weigh the information in an unbiased fashion	17					113				205				3	3/110

Effect of Prior Knowledge: Negative

	12-30	31-50	51-70	71-90	91-110	111-130	131-150	151-170	171-190	191-210	211-230	231-250	251-270		**Total /number of investigators**
Negative: Prior knowledge hinders the collection and interpretation of information, as well as, investigative decision making and objectivity.	13, 13, 13, 18	35, 35, 45, 50, 55, 33	52, 55 58, 65, 69, 52, 69, 65	79, 80, 83, 75, 83, 80, 80, 86, 83, 86	97, 108, 106, 97, 108	116, 119, 116	139, 145, 148	157, 158, 158, 162, 163, 170, 159, 161, 162, 163	175, 180, 183, 187, 190, 174, 177, 180, 181, 181,	194, 207, 210, 210	218, 221, 222, 222, 223, 223, 225	235, 244, 244 247, 248, 249, 239, 244, 248, 239,	260, 262, 253	**/total # of unique statements**	57/110

								153, 159	180, 183			244			
1. Information collection: Negatively influences how information is sought and collected.	13, 13*, 18, 18*		55, 69	80, 83, 83*	108			163	187, 181, 174, 177	194, 207	225, 222	244, 248, 248*		22	18/110
i. How information is sought:	13, 13*, 18		55, 69	83*	108			163		194, 207		244		11	
a) Time: Prior knowledge leads the investigator to spend less time collecting information.	13		55		108									3	
b) Thoroughness: Prior information leads to a less thorough investigation e.g., may stop prematurely.	13*		55, 69					163		194, 207		244		7	
c) Questioning: Quality of the questioning is diminished because of prior knowledge.	18			83*										2	
ii) What information is sought.	18*			80					181, 187		225			5	
a) Consistent: Prior knowledge can lead investigators to seek information which is consistent with their misperceptions.	18*			80					181, 187		225			5	
iii) Source of Information.											222	248*		2	
a) Biased people information:											222	248*		2	

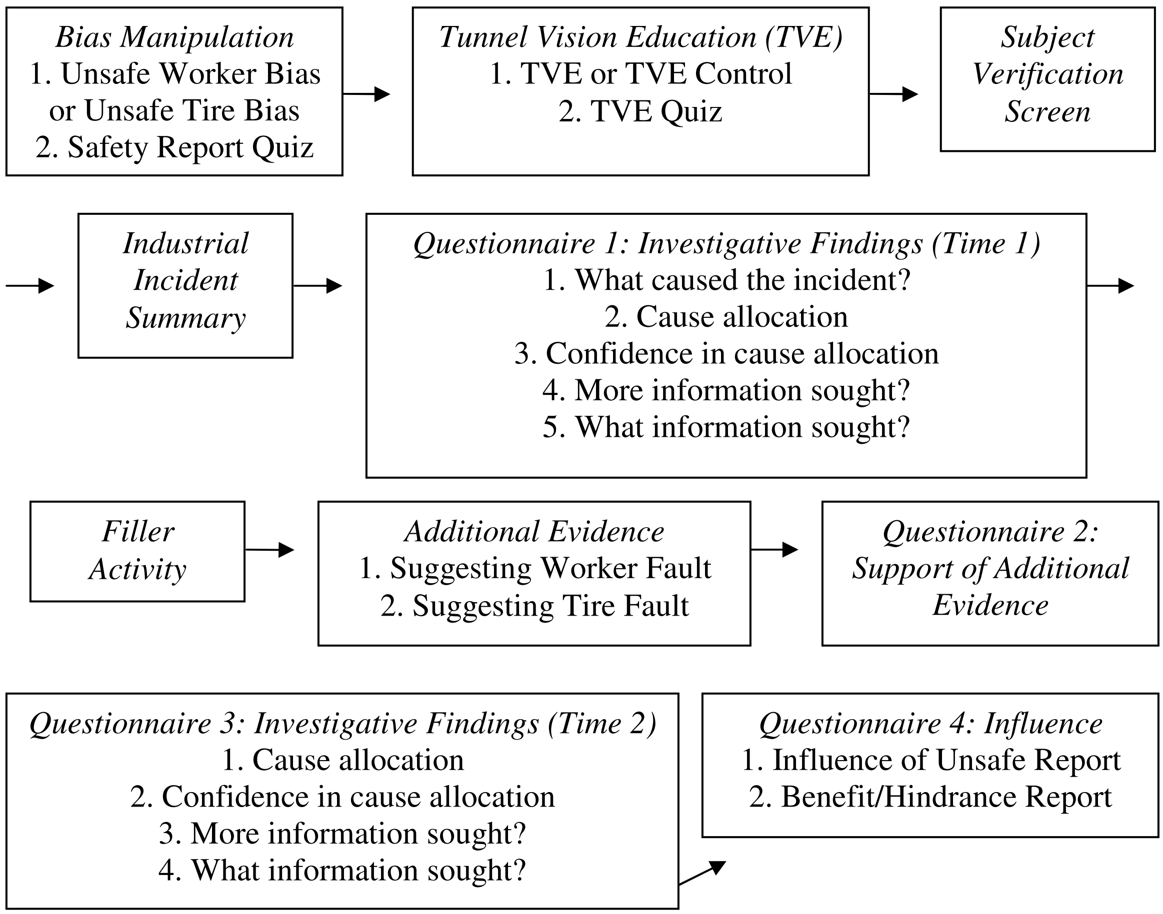
Prior knowledge biases the interviewee's information.															
2. *Interpretation of information:* Knowledge leads to biased interpretation of the information.	13	33, 45	58, 52, 65, 69, 69*, 69	80, 86, 83, 83	97,	116	145, 148	162, 162* 170	174, 177, 187		221, 222, 222*, 222, 225	239, 249, 244, 244* 244*, 239*	260	32	26/110
i) Intentional: Intimacy with an issue leads to **intentionally** considering the evidence improperly: overlook information.			69*						174		222*, 222			4	
ii) Unintentional: Intimacy leads to **unintentionally** considering the evidence improperly (e.g. good safety record leads to biased interpretation of the facts).		45	52, 58, 65, 69, 69	83, 83 , 80,			148	162, 170			221, 222	249, 244, 239*	260	16	
iii) Undue weight: Prior knowledge may lead to information being given more weight in decision making.				80, 86	97,	116			177, 187		221	244*		8	
3. *Decision making:* Prior knowledge negatively influences investigative decision making.	13	35, 33	55, 58, 65, 65	79, 80, 83, 83*, 86 , 80*	97, 108, 108*	116, 119, 116*	139	159, 159, 162, 163, 163	174, 181, 181 180, 183, 180*, 183*	194, 210, 210	223, 223*	235, 244 247, 239, 248	262	39	32/110
i) Inaccurate expectations: Prior knowledge leads to erroneous assumptions and		33		79, 80, 83,	97, 108*	116, 119		162	180, 183	210, 210	223, 223*			16	

expectations.				83											
ii) Inaccurate conclusions: Prior knowledge leads to the investigator to jump to erroneous conclusions.	13		55, 65, 65	79, 83*, 86 , 80*	108	116*	139	159, 159, 162, 163, 163	181, 180*, 183*, 181	194		235, 247, 244, 239, 248	262	27	
4. Objectivity: Prior knowledge negatively influences objectivity.		50, 33	52		106	116		157, 158, 158*, 161, 153	175, 190	210	218, 223, 225, 223*,	248, 249		19	17/110

Omitted: # 101, 108, 264, 205

APPENDIX C

Procedure Summary: Study 2 and Study 3



APPENDIX D

Undergraduate Investigator Introductory Slideshow

Welcome to our Experiment

Next Slide

Who are you?

- In this experiment you are to assume the role of a workplace accident investigator.

Next Slide

Who are you?

- A workplace investigator investigates:
  1) What happened during a workplace accident, and
  2) What caused the accident to happen.

Next Slide

What Happened vs. Causation

- What happened: Those things that happened during the incident.
  Example: Tom was walking through the shop and slipped on the water by the cooler.

Next Slide

What Happened vs. Causation

- What happened: Those things that happened during the incident.
  Example: Tom was walking through the shop and slipped on the water by the cooler.
- Causation: Those things that caused the accident to happen.
  Example: Tom slipped *because* a seal has broken in the cooler causing water leakage.

Next Slide

What Happened vs. Causation

Quiz

- Accident: Janet was climbing up the scaffolding when the rung she was holding onto broke. Janet fell and hit her head on the pavement. A review of the paperwork revealed that a crack had been observed in the rung that broke in the accident.
- What happened?
- What caused it?

Next Slide

What Happened

What is the best answer to what happened?

- A) Janet hit her head on the pavement.
- B) Janet was climbing up the scaffolding when the rung she was holding onto broke. Janet fell and hit her head on the pavement.
- C) The rung Janet was holding onto broke.

Next Slide →

What Happened

✓ B) Janet was climbing up the scaffolding when the rung she was holding onto broke. Janet fell and hit her head on the pavement.

Next Slide →

Causation

What is the best answer to what caused the accident?

- A) The rung Janet was holding onto broke.
- B) A pre-existing crack in the rung.
- C) A broken rung most likely caused by a pre-existing crack.

Next Slide →

Causation

What is the best answer to what caused the accident?

✓ C) A broken rung most likely caused by a pre-existing crack.

Next Slide →

What is your Job?

- Your job over the next 30 minutes is to:

I) determine what happened in the industrial incident,

II) determine what caused the accident to happen, and

III) allocate blame for the incident.

Next Slide →

What is your Job?

- The case information that you are going to read was a true incident that happened in BC.
- To ensure anonymity we have omitted identifying information and changed the format of some of the information you are receiving.

Next Slide →

Bonus • If you are correct in the your investigative conclusions, in addition to the bonus point, you will be entered into a draw to win **$100**. • Good Luck!	

APPENDIX E

Undergraduate Bias Manipulation Materials

Hypothesis Generation

Before engaging in this study's industrial investigation we would like you to practice your investigative skills. We are interested in how effectively you can use limited information to hypothesize a probable cause of an industrial accident. On the following pages you will receive:

1. Background information about a Tire man and Tire
2. Information about an industrial accident.

Once you have received this information you will be asked to generate a plausible explanation for the accident.

Example: Tire Man Unsafe Safety Report

TIRE MAN

SAFETY REPORT
MARCH 2005 – MARCH 2008

SAFETY OVERVIEW

Tire man: Edward Price

- Workplace safety reports indicate a poor safety history for this tire man.
- Although unverified, this tire man is suspected of causing 2 near misses (unplanned event that does not cause injury, damage or ill health but could do so) on the worksite in the last year
- This tire man has been found responsible for 2 accidents and 1 near miss in the last 3 years.
- The 2 accidents discussed above resulted in injury to 3 employees and cost the organization $20,000 in damages.

SAFETY PERFORMANCE MEASURE

- The Safety Performance measure is a tool used to assess an employee's overall level of safety.
- This assessment measure takes into account a) the employee's history of accidents and near misses within the organization, b) the employee's history of accidents and near misses within other organizations, c) supervisor's performance reports of the employee, and d) on-site workers' reviews of the employee's safety.
- Scoring Criteria: Employee's safety is scored on a scale of 0-100.

RESULTS: Tire man: Edward Price:
Safety Performance Score = 89

Extremely Safe Score: 0-20	Safe Score: 21-40	Somewhat Safe Score: 41-60	Unsafe Score: 61-80	Extremely Unsafe Score: 81-100
				X

Special Note

- A Safety Performance Score of 89 typically results in termination of the negligent employee.
- Current organizational financial limitations demand that he be keep on as an employee.
- The organization will terminate this employee once financial pressures are alleviated in the next couple of months.

Example: Tire Unsafe Safety Report

SAFETY REPORT
MARCH 2005 – MARCH 2008

TIRE

SAFETY OVERVIEW

Tire Model: Michelin Model X1273

- Workplace safety reports indicate a poor safety history for this tire model.
- Although unverified, this tire model is suspected of causing 2 near misses (unplanned event that does not cause injury, damage or ill health but could do so) on the worksite in the last year.
- This tire model has been found responsible for 2 accidents and 1 near miss in the last 3 years.
- The 2 accidents discussed above resulted in injury to 3 employees and cost the organization $20,000 in damages.

SAFETY PERFORMANCE MEASURE

- The Safety Performance Measure is a tool used to assess the equipment's overall level of safety.
- This assessment measure takes into account a) the equipment's history of accidents and near misses within the organization, b) the equipment's history of accidents and near misses within other organizations, c) supervisor's performance reports of the equipment, and d) on-site workers' reviews of the equipment's safety.
- Scoring Criteria: Equipment's safety is scored on a scale of 0-100.

RESULTS: Tire: Michelin Model X1273:
Safety Performance Score = 89

Extremely Safe Score: 0-20	Safe Score: 21-40	Somewhat Safe Score: 41-60	Unsafe Score: 61-80	Extremely Unsafe Score: 81-100
				X

Special Note

- A Safety Performance Score of 89 typically results in elimination of the faulty equipment from the work site.
- Current organizational financial limitations demand that it be keep in use.
- The organization will terminate this tire model's use once financial pressures are alleviated in the next couple of months.

Example: Tire Neutral Safety Report

SAFETY REPORT
MARCH 2005 – MARCH 2008

TIRE

SAFETY OVERVIEW

Tire Model: Michelin Model X1273

- No notable incidents of unsafe behaviour in this tire's work history.

SAFETY PERFORMANCE MEASURE.

- The Safety Performance Measure is a tool used to assess the equipment's overall level of safety.
- This assessment measure takes into account a) the equipment's history of accidents and near misses within the organization, b) the equipment's history of accidents and near misses within other organizations, c) supervisor's performance reports of the equipment, and d) on-site workers' reviews of the equipment's safety.
- Scoring Criteria: Equipment's safety is scored on a scale of 0-100.

RESULTS: Tire: Michelin Model X1273: Safety Performance Score = 50

Extremely Safe Score: 0-20	Safe Score: 21-40	Somewhat Safe Score: 41-60	Unsafe Score: 61-80	Extremely Unsafe Score: 81-100
		X		

Example: Worker Neutral Safety Report

TIRE MAN

SAFETY REPORT
MARCH 2005 – MARCH 2008

SAFETY OVERVIEW

Tire man: Edward Price

- No notable incidents of unsafe behaviour in this tire man's work history.

SAFETY PERFORMANCE MEASURE.

- The Safety Performance measure is a tool used to assess an employee's overall level of safety.
- This assessment measure takes into account a) the employee's history of accidents and near misses within the organization, b) the employee's history of accidents and near misses within other organizations, c) supervisor's performance reports of the employee, and d) on-site workers' reviews of the employee's safety.
- Scoring Criteria: Employee's safety is scored on a scale of 0-100.

RESULTS: Tire man: Edward Price:
Safety Performance Score = 50

Extremely Safe Score: 0-20	Safe Score: 21-40	Somewhat Safe Score: 41-60	Unsafe Score: 61-80	Extremely Unsafe Score: 81-100
		X		

Safety Report Quiz

According to the background information you just received in the Safety Reports:

1. How many accidents has the **tire** *(or tire man)* been responsible for in the last 3 years?

○	○	○	○	○
0	2	10	14	25

2. What safety rating did the **tire** *(or tire man)* receive on the safety performance measure?

Extremely Safe	Safe	Somewhat Safe	Unsafe	Extremely Unsafe
◉	○	○	○	○
Score: 0-20	Score: 21-40	Score: 41-60	Score: 61-80	Score: 81-100

3. What safety rating did the **tire man** *(or tire)* receive on the safety performance measure?

Extremely Safe	Safe	Somewhat Safe	Unsafe	Extremely Unsafe
○	○	○	○	○
Score: 0-20	Score: 21-40	Score: 41-60	Score: 61-80	Score: 81-100

Hypothesis Generation Exercise

Unsafe Tire Condition

Please read the facts of the following industrial incident carefully.

Please use this information to create a probable scenario of tire fault for the accident.

Name of Person Reporting Incident [redacted]	Site *(business and location)* [redacted]		Incident No. [redacted]
Primary Type of Incident **Injury**	Severity Level		
Exact Location of Incident [redacted]	Date / Time of Incident [redacted]	Date Reported [redacted]	Date of Investigation [redacted]
Facility Condition [redacted]			

- Tire man changed the tire on the work truck.
- At the beginning of the shift, the truck was moved to a sloped section of the worksite and parked diagonally on the hill.
- A worker was working in the bucket of the truck.
- The worker in the bucket noticed that the truck had an exaggerated lean.
- The truck then leaned sharply on the slope.
- The worker was unable to balance with the abrupt shift.
- The worker fell from the bucket down a steep embankment.
- This fall resulted in a significant worker injury. This injury led to an eventual amputation of the worker's leg.
- Findings indicate that the newly replaced truck tire was void of all air when examined at the accident site.

Given your knowledge of the tire involved in this incident please generate a plausible explanation that supports that the tire was at fault for this accident:

Hypothesis Generation Exercise

Unsafe Worker Condition

- Please read the facts of the following industrial incident carefully.
- Please use this information to create a probable scenario of tire man fault for the accident.

Name of Person Reporting Incident	Site *(business and location)*			Incident No.
[redacted]	[redacted]			[redacted]
Primary Type of Incident **Injury**	Severity Level			
Exact Location of Incident [redacted]	Date / Time of Incident [redacted]	Date Reported [redacted]	Date of Investigation [redacted]	
Facility Condition [redacted]				

- Tire man changed the tire on the work truck.
- At the beginning of the shift, the truck was moved to a sloped section of the worksite and parked diagonally on the hill.
- A worker was working in the bucket of the truck.
- The worker in the bucket noticed that the truck had an exaggerated lean.
- The truck then leaned sharply on the slope.
- The worker was unable to balance with the abrupt shift.
- The worker fell from the bucket down a steep embankment.
- This fall resulted in a significant worker injury. This injury led to an eventual amputation of the worker's leg.
- Findings indicate that the newly replaced truck tire was void of all air when examined at the accident site.

Given your knowledge of the tire man involved in this incident please generate a plausible explanation that supports that the tire man was at fault for this accident:

APPENDIX F

Tunnel Vision Education Intervention and TVE Manipulation Check

Quiz

What is tunnel vision?

- A) A visual disorder where one only sees things that look like tunnels,
- B) A cable tv channel exploring the wonders of tunnels, or
- C) A phenomenon in investigation where those seeking information tend to search for information that supports their beliefs while ignoring or minimizing disconfirming information.

Next Slide

✓ C) A phenomenon in investigation where those seeking information tend to search for information that supports their beliefs while ignoring or minimizing disconfirming information.

Next Slide

- In the following slide show you are going to learn about investigative tunnel vision.
- Please pay attention as you will be quizzed on the content of this show once it is over.
- The information contained in this slide show may help you in the investigation that follows.

Next Slide

- You are about to read two fictitious cases of investigative tunnel vision.

In the following cases, the workplace accident investigator was wrong about the cause of the workplace accident.

Worker Fault

Bill found at fault for a workplace accident.

Bill lost his job.

Accident was not Bill's fault.

Equipment Fault

Equipment found at fault for the accident.

Debilitating worker injury 1 month later.

Equipment was not at fault.

http://www.xstrata.com/annualreport/2006/img/ar06_img08301.jpg

Next Slide

Worker Fault

Next Slide

Bill's Story:

An Example of Tunnel Vision

- **Incident:** Over the lunch break, the cart that Bill had been operating just prior to the break started into motion.
- The cart pinned Sarah against the wall causing her injury to her hip.

Next Slide

Bill's Story: An Example of Tunnel Vision • Bill has been in counselling recently because his wife has left him. • Bill seems to not be thinking about the job when at work lately. • The investigator, who is attempting to determine what caused the accident, sees that the cart's emergency break is not engaged. • The lack of emergency break is what led the cart to move down the embankment and hit Sarah. **Next Slide**	Bill's Story: An Example of Tunnel Vision **Investigator's Conclusion:** • Investigator concludes that Bill's personal problems led him to absentmindedly leave the cart without engaging the emergency break. **Next Slide**
Bill's Story: An Example of Tunnel Vision **True Cause:** • If the investigator probed more carefully he would have found that the emergency break on Bill's cart has a tendency to slip out of position. **Next Slide**	Bill's Story: An Example of Tunnel Vision **The investigator jumped to the conclusion that Bill was at fault when in fact there was more evidence to consider.** **This wrong conclusion cost Bill his job and his reputation.** **Next Slide**
Equipment Fault **Next Slide**	Earl and Tony's Story: An Example of Tunnel Vision • **Incident:** Earl's job on the construction site is to manage the scaffolding set up. • One month before the accident which injured Tony, high winds caused the scaffolding to fall backwards from the building. • Luckily no one was on the scaffolding at the time and no one was injured by the toppling structure. **Next Slide**

Earl and Tony's Story:
An Example of Tunnel Vision

- The investigator examined the toppled scaffolding.
- He found that the scaffolding toppled because the screws that hold the scaffolding to the building had pulled out of the building.
- The screws had been used before, thus, the thread on them was worn down.
- Additionally, the screws had been purchased from a competitor going out of business and were smaller than what Earl and Tony's company typically use.

Next Slide →

Earl and Tony's Story:
An Example of Tunnel Vision

Investigator's Conclusion:

- Investigator concludes that the size and integrity of the screws led to the scaffolding toppling.
- A new set of larger screws were ordered.

Next Slide →

Earl and Tony's Story:
An Example of Tunnel Vision

- One month later: Earl has used the new screws to set up the scaffolding.
- Tony is on the scaffolding attaching aluminium siding to a condominium development.
- The scaffolding topples causing Tony to fall backwards with the scaffolding approx 17 feet onto the ground below.
- Tony suffered head trauma and a broken back.

Next Slide →

Earl and Tony's Story:
An Example of Tunnel Vision

True Cause:

- If the investigator probed more carefully he would have found that Earl was not using the screws properly.
- To be considered safe, the screws need to be imbedded in the wood frame of the building.
- Careful assessment of the equipment would have shown that Earl was imbedding the screws in the weak plywood on the side of the building.

Next Slide →

Earl and Tony's Story:
An Example of Tunnel Vision

The investigator jumped to the conclusion that the equipment was at fault when in fact there was more evidence to consider.

This wrong conclusion cost Tony his physical health.

Next Slide →

The Problem of Tunnel Vision

- Tunnel vision can lead to wrong conclusions about incident causation.
- However, tunnel vision will not always lead to an inaccurate conclusion,

  e.g., it could be that Bill did forget to engage the emergency break or that the screws were faulty.

Next Slide →

Considering Alternatives

Next Slide →

Alternative Hypotheses

- It is critical that investigators actively seek *alternative explanations* for the accident.
  - An example of testing alternative hypotheses:
    - Your job is to discover a rule to a game.
    - You are told that the number string 2-4-6 adheres to the rule.
    - You propose 6-8-10 and 21-23-25 and are told your numbers fit the rule.
    - You conclude that the rule is: numbers differing by 2's.
    - Your conclusion is wrong, the rule is: ascending numbers.
    - If you considered alternative hypotheses you would have seen that 3,4,5 fit the rule and 12–10-8 did not.

Next Slide →

- Like the number game, investigators in Bill and Tony's cases should have asked themselves:

"What evidence would make my hypothesis *not* true?" or

"What information *disconfirms* my hypothesis of what happened?" or

"Could this evidence support a different hypothesis?
e.g., blame to the equipment or worker opposed to blame to the worker or environment?

- Investigators should not be simply asking:
  "What information supports my hypothesis of what happened"

Next Slide →

The Problem of Tunnel Vision

- An investigator *focusing on the wrong evidence* or *not considering all the information* could result in someone like Bill losing his job or someone like Tony suffering physical damage.

Next Slide →

What Can You Do About It?

2 Things

Next Slide →

What to Do About It?

#1: Be Aware

- **Be aware** of your biases and how they can influence your investigation.
- Try reflecting on your preconceived ideas regarding the people, machinery, or other elements involved in the incident before beginning the investigation.

Next Slide →

What to Do About It?

#2: Consider the Alternative

- Consider **alternative hypotheses.**
- Before subscribing to one investigative outcome, assess if there are alternative hypotheses to consider.
- Ask yourself if the evidence could support another explanation for the event and if there is evidence that disconfirms your hypothesis.

Next Slide →

Conclusion

Being aware of your preconceived ideas and entertaining *different hypotheses* may lead to more objective conclusions about what caused the accident.

Tunnel Vision Quiz

Now that you have finished learning about tunnel vision please take the following tunnel vision quiz:

1. Tunnel vision is:
   - ○ A term used to talk about how an eyewitness views an emotionally charged incident,
   - ○ A phenomenon in investigation where those seeking information tend to search for information that supports their beliefs while ignoring or minimizing disconfirming information,
   - ○ A flattering way of describing someone's investigative style "he solves investigations so well, he must have tunnel vision".
2. How did the investigator investigating Bill's case engage in tunnel vision?
   - ○ He did not collect all the evidence and made an assumption based on prior knowledge that Bill was at fault,
   - ○ He collected a wide body of evidence and concluded that Bill was at fault after considering all the information,
   - ○ He used multiple witnesses to help construct a story of what happened.
3. How did the investigator investigating the collapsed scaffolding engage in tunnel vision?
   - ○ He failed to consider Tony's ability to put up aluminum siding,
   - ○ He used his knowledge of the screws and jumped to the conclusion that the equipment was faulty when in fact Earl was inaccurately using the screws,
   - ○ He used multiple witnesses to help construct a story of what happened.
4. The slide show you just viewed provided 2 ways that you can attempt to prevent tunnel vision. Please select the 2 ways discussed from the 4 options provided below:
   - ☐ Use multiple sources of information in the investigation,
   - ☐ Be aware of your biases before beginning the investigation,
   - ☐ Use an investigator who knows the people on the job site,
   - ☐ Consider alternative hypotheses before deciding on one cause of the incident.

APPENDIX G

Subject Verification Screen

Bias Manipulation Check

You are about to investigate a workplace accident.

The following subjects were on the job site when the accident occurred.

Please verify that you received safety information about the subjects in the above photos:

- ☐ **Yes**, I received safety information about the subjects in the photos.

- ☐ **No**, I did not receive safety information about the subjects in the photos.

APPENDIX H

Industrial Incident Summary

- Four event summaries were created: (1)red truck/young worker, (2) red truck/older worker, (3) blue truck/young worker, (4) blue truck/older worker.
- Below is an example of an incident summary, specifically, blue truck/older worker.

Industrial Accident Description

Date of Incident: Unit: Age:

Incident: Tire Explosion / Worker Injury

Description:

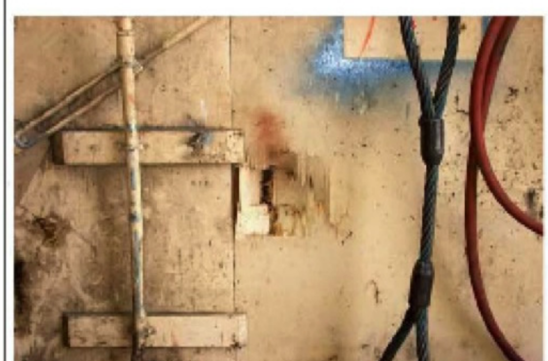
Tire man was replacing the right front tire on a truck located inside the maintenance shop. Having partially filled and mounted the new tire, the tire man attrached the air hose and continued to fill the tire with air. When at capacity, the tire man moved to the left of the tire to shut off the air flow to the tire. It was at that moment that the tire violently exploded, forcing the tire off and away from the axle. The tire man, located safely to the left of the tire, was uninjured.

Another worker, who had been retrieving materials from a bench behind the tire man when he was working on the tire, was now located directly in the tire's path and was not able to avoid the exploding tire (marked by the x). The worker was driven back 6 feet until his head struck the shop wall and the tire came to rest on top of him. This resulted in severe head lacerations and chest trauma.

This explosion forced the worker's head into the 3/8" plywood causing a 3" deep impression into the wall.

Uninjured Tire Man

Tire



WCB estimated the explosive force equal to 3-4 sticks of dynamite.

Injured Worker

Tire

APPENDIX I

Questionnaire 1: Investigative Findings Time 1

Investigator Questionnaire 1

1. Please describe, in as much detail as possible, what happened in the accident:

2. What do you think could have caused the accident:

3. Rate your confidence on a scale of 0-100 in your response to question 2.

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

4. Please allocate 100% of the blame for the incident into the following three categories (e.g., 30,40,30 or 10,10,80):

Tire Man Fault
Tire Fault
Other Factors:

5. Rate your confidence on a scale of 0-100 in the accuracy of the blame allocation you proposed in question 4.

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

6. If you were to stop right now, do you feel you have an adequate amount of information to reach a conclusion about *what caused* the accident?

○	○	○	○	○	○	○	○	○
Information is *not adequate*: Far more information is needed.		Information is *slightly adequate*: Some more information is needed.		Information is *somewhat adequate*: A little more information is needed.		Information is *mostly adequate*: More information would be nice but it is not needed.		Information is *adequate*: No more information is needed.

7. Of the new information that you require please indicate what type of information you would seek by allocating 100% of your new information into the following three categories.

☐ Tire Man Information: (indicate the worker information you would find helpful below)

☐ Tire Information: (indicate the tire information you would find helpful below)

☐ Other Information: (indicate the other information you would find helpful below)

APPENDIX J

Additional Evidence and Questionnaire 2

Additional Evidence 1: Tire Man Fault

[redacted] 1 **Safety Incident Investigation Report - Web Form Export**

Name of Person Reporting Incident	Site *(business and location)*	Incident No.
[redacted]	**Lower Mainland**	**1227276**

Primary Type of Incident	Severity Level
Injury	

Exact Location of Incident	Date / Time of Incident	Date Reported	Date of Investigation
[redacted]	**9/15/2007 15:25**	**9/15/2007**	**9/15/2007**

Facility Condition

Upset

Investigator Notes

- assessment of the tire inventory indicates that the tire man may have use a tire too small for the tire rim
- although it happens rarely, tires can explode if the tire size is too small for the rim

Approvals

Investigation Leader's Signature	Date
Safety Committee Representative's Signature	Date
Approved By Next Level Manager *(for a level 1 & 2 incident, must be two levels above team leader)*	Date

Investigator Questionnaire 2

1a.	Please indicate how valuable you believe this new information is to your investigation.

○	○	○	○	○	○	○	○	○
Valuable The new information is relevant to the investigation.		Somewhat Valuable The new information is somewhat relevant to the investigation.		Slightly Valuable The new information is slightly relevant to the investigation.		Of little Value The new information is somewhat irrelevant to the investigation.		Of no Value The new information is irrelevant to the investigation.

2a.	Please indicate how supportive the new information is to your original hypothesis of what caused the accident.

○	○	○	○	○	○	○	○	○
Extremely Supportive; Completely reinforced what I had originally determined.		Supportive; Mostly reinforced what I had originally determined.		Neutral; Did not support or discount what I originally determined.		Unsupportive; Did not reinforce what I had originally determined.		Extremely Unsupportive; Absolutely did not support what I had originally determined.

Additional Evidence 2: Tire Fault

[redacted] 9 **Safety Incident Investigation Report - Web Form Export**

Name of Person Reporting Incident	Site *(business and location)*	Incident No.
[redacted]	**Lower Mainland**	**1227276**

Primary Type of Incident	Severity Level
Injury	

Exact Location of Incident	Date / Time of Incident	Date Reported	Date of Investigation
[redacted]	**9/15/2007 15:25**	**9/15/2007**	**9/15/2007**

Facility Condition

Upset

Investigator Notes

- the model of tire involved in this incident has a poor safety record
- this tire model has been involved in 25 instances of explosion in the last five years
- there are hundreds of this model of tire in circulation, these safety stats are not significant enough for the manufacturer to recall the tires

Approvals

Investigation Leader's Signature	Date
Safety Committee Representative's Signature	Date
Approved By Next Level Manager *(for a level 1 & 2 incident, must be two levels above team leader)*	Date

Investigator Questionnaire 2

1b. Please indicate how valuable you believe this new information is to your investigation.

Valuable		Somewhat Valuable		Slightly Valuable		Of little Value		Of no Value
The new information is relevant to the investigation.		The new information is somewhat relevant to the investigation.		The new information is slightly relevant to the investigation.		The new information is somewhat irrelevant to the investigation.		The new information is irrelevant to the investigation.

2b. Please indicate how supportive the new information is to your original hypothesis of what caused the accident.

Extremely Supportive;		Supportive;		Neutral;		Unsupportive;		Extremely Unsupportive;
Completely reinforced what I had originally determined.		Mostly reinforced what I had originally determined.		Did not support or discount what I originally determined.		Did not reinforce what I had originally determined.		Absolutely did not support what I had originally determined.

APPENDIX K

Questionnaire 3: Investigative Findings Time 2

Investigator Questionnaire 3

Your investigation is now complete and it is time for you to provide your final conclusions about what caused the industrial accident. Please take your time as your eligibility in the $100 draw is based on these conclusions.

1. Please describe, in as much detail as possible, what happened in the accident:

2. What do you believe *caused* the accident?

3. Rate your confidence on a scale of 0-100 in the cause of the accident proposed in question 2.

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

4. Please allocate 100% of the blame for the incident into the following three categories (e.g., 30,40,30 or 10,10,80):

Tire Man Fault

Tire Fault

Other Factors:

5. Rate your confidence on a scale of 0-100 in the accuracy of the blame allocation you proposed in question 4.

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

6. Do you feel you had an adequate amount of information to reach a conclusion about *what caused* the accident?

Information is *not adequate*: Far more information is needed.		Information is *slightly adequate*: Some more information is needed.		Information is *somewhat adequate*: A little more information is needed.		Information is *mostly adequate*: More information would be nice but it is not needed.		Information is *adequate*: No more information is needed.

7. Of the new information that you require please indicate what type of information you would seek by allocating 100% of your new information into the following three categories.

Tire Man Information: (indicate the worker information you would find helpful below)

Tire Information: (indicate the tire information you would find helpful below)

Other Information: (indicate the other information you would find helpful below)

8. Using the following scale of 0 - 100, rate your confidence that you are going to be entered in the draw to win $100 as a result of your investigative conclusions (i.e., your written statement of what happened, your conclusion of what caused the event and your final blame allocation).

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

APPENDIX L

Questionnaire 4: Influence of Previous Information

Unsafe Tire Condition

Influence

- At the beginning of this experiment you learned about a tire's accident proneness via a safety report.
- The safety report indicated the tire's record of accidents and near misses as well as its rating on the safety performance measure.
- You then engaged in a practice exercise which asked you to generate a plausible explanation that supported tire fault for an accident.
- Once this was completed you began the true industrial accident investigation.

The following questions query if the *safety report* about the tire guided your *true* investigation.

1a. Did the safety report about the tire influence how you *wrote your statements about what happened* in the accident? (click here to see the referenced question)

○	○	○	○	○	○	○	○	○
Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

1b. How did the tire's safety information influence your *written statements* of what happened?

○	○	○	○	○	○	○	○	○
Only negative influence Information only distorted my written statement of what happened.		*Mostly negative* influence Information mostly distorted but slightly helped my written statement of what happened.		*Moderately negative and moderately positive* Information moderately distorted and moderately helped my written statement of what happened.		*Mostly positive* influence Information mostly helped but slightly distorted my written statement of what happened.		*Only positive* influence Information only helped my written statement of what happened.

2a. Did the safety report about the tire influence how you allocated blame for the cause of the accident? (click here to see the referenced question)

Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

2b. How did the tire's safety information influence your blame allocation of what caused the accident?

Only negative influence Information only biased my blame allocation.		*Mostly negative* influence Information mostly biased but slightly helped with my blame allocation.		*Moderately negative and moderately positive* Information moderately biased and moderately helped with my blame allocation.		*Mostly positive* influence Information mostly helped but slightly biased my blame allocation.		*Only positive* influence Information only helped with my blame allocation.

3a. Did the safety report about the tire influence your conclusions in regards to whether you had *enough information* to determine what *caused the accident*? (click here to see the referenced question)

Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

3b. How did the tire's safety information influence your ratings of whether you had enough information?

Only negative influence Information only biased my ratings of the amount of information I needed.		*Mostly negative* influence Information mostly biased but slightly helped with my ratings of the amount of		*Moderately negative and moderately positive* Information moderately biased and moderately helped with my ratings of the amount of		*Mostly positive* influence Information mostly helped but slightly biased my ratings of the amount of		*Only positive* influence Information only helped with my ratings of the amount of information I needed.

		information I needed.		information I needed.		information I needed.		

4a. Did the safety report about the tire influence your ratings of *what new information* you were interested in acquiring (i.e., tire man, tire, or other)? (click here to see the referenced question)

◯	◯	◯	◯	◯	◯	◯	◯	◯
Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

4b. How did the tire's safety information influence what new information you required?

◯	◯	◯	◯	◯	◯	◯	◯	◯
Only negative influence Information only biased me in determining what new information I required.		*Mostly negative* influence Information mostly biased but slightly helped me in determining what new information I required.		*Moderately negative and moderately positive* Information moderately biased me and moderately helped me in determining what new information I required.		*Mostly positive* influence Information mostly helped but slightly biased me in determining what new information I required.		*Only positive* influence Information only helped me in determining what new information I required.

5a. After making your initial ratings and viewing a set of illusions you were provided with two additional pieces of information about the accident.

Did the safety report about the tire influence your *interpretation of the additional information* you acquired about the accident?

◯	◯	◯	◯	◯	◯	◯	◯	◯
Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

5b. How did the tire's safety information influence your interpretation of the additional evidence?

◯	◯	◯	◯	◯	◯	◯	◯	◯
Only negative influence		*Mostly negative* influence		*Moderately negative and moderately positive*		*Mostly positive* influence		*Only positive* influence

Information only distorted my understanding of the additional evidence.		Information mostly distorted but slightly clarified my understanding of the additional evidence.		Information moderately distorted and moderately clarified my understanding of the additional evidence.		Information mostly clarified but slightly distorted my understanding of the additional evidence.		Information only clarified my understanding of the additional evidence.

6. Overall, how objective do you feel you have been in approaching the evidence and making decisions about what happened and what caused the industrial accident?

○	○	○	○	○	○	○	○	○
Not at all objective		Slightly objective		Moderately objective		Highly objective		Extremely objective

7. Do you feel that the education you received about tunnel vision at the beginning of the study influenced your objectivity in this investigation study?

○	○	○	○	○	○	○	○	○
Education *definitely hindered* my objectivity		Education *slightly hindered* my objectivity		Education *did not influence* my objectivity		Education *slightly helped* my objectivity		Education *definitely helped* my objectivity

Unsafe Worker Condition

Influence

- At the beginning of this experiment you learned about a tire man's accident proneness via a safety report.
- The safety report indicated the tire man's record of accidents and near misses as well as his rating on the safety performance measure.
- You then engaged in a practice exercise which asked you to generate a plausible explanation that supported tire man fault for an accident.
- Once this was completed you began the true industrial accident investigation.

The following questions query if the *safety report* about the tire man guided your *true* investigation.

1a. Did the safety report about the tire man influence how you *wrote your statements about what happened* in the accident? (click here to see the referenced question)

○	○	○	○	○	○	○	○	○
Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

1b. How did the tire man's safety information influence your *written statements* of what happened?

○	○	○	○	○	○	○	○	○
Only negative influence Information only distorted my written statement of what happened.		*Mostly negative* influence Information mostly distorted but slightly helped my written statement of what happened.		*Moderately negative and moderately positive* Information moderately distorted and moderately helped my written statement of what happened.		*Mostly positive* influence Information mostly helped but slightly distorted my written statement of what happened.		*Only positive* influence Information only helped my written statement of what happened.

2a. Did the safety report about the tire man influence how you *allocated blame* for the cause of the accident? (click here to see the referenced question)

○	○	○	○	○	○	○	○	○
Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

2b. How did the tire man's safety information influence your blame allocation of what caused the accident?

○	○	○	○	○	○	○	○	○
Only negative influence Information only biased my blame allocation.		*Mostly negative* influence Information mostly biased but slightly helped with my blame allocation.		*Moderately negative and moderately positive* Information moderately biased and moderately helped with my blame allocation.		*Mostly positive* influence Information mostly helped but slightly biased my blame allocation.		*Only positive* influence Information only helped with my blame allocation.

3a. Did the safety report about the tire man influence your conclusions in regards to whether you had *enough information* to determine what *caused the accident*? (click here to see the referenced question)

○	○	○	○	○	○	○	○	○
Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

3b. How did the tire man's safety information influence your ratings of whether you had enough information?

○	○	○	○	○	○	○	○	○
Only negative influence Information only biased my ratings of the amount of information I needed.		*Mostly negative* influence Information mostly biased but slightly helped with my ratings of the amount of information I needed.		*Moderately negative and moderately positive* Information moderately biased and moderately helped with my ratings of the amount of information I needed.		*Mostly positive* influence Information mostly helped but slightly biased my ratings of the amount of information I needed.		*Only positive* influence Information only helped with my ratings of the amount of information I needed.

4a. Did the safety report about the tire man influence your ratings of what *new information* you were interested in acquiring (i.e., tire man, tire, or other)? (click here to see the referenced question)

Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

4b. How did the tire man's safety information influence what new information you required?

Only negative influence Information only biased me in determining what new information I required.		*Mostly negative* influence Information mostly biased but slightly helped me in determining what new information I required.		*Moderately negative and moderately positive* Information moderately biased me and moderately helped me in determining what new information I required.		*Mostly positive* influence Information mostly helped but slightly biased me in determining what new information I required.		*Only positive* influence Information only helped me in determining what new information I required.

5a. After making your initial ratings and viewing a set of illusions you were provided with two additional pieces of information about the accident.

Did the safety report about the tire man influence your *interpretation of the additional information* you acquired about the accident?

Not at all		Slightly Influenced		Somewhat Influenced		Highly Influenced		Extremely Influenced

5b. How did the tire man's safety information influence your interpretation of the additional evidence?

Only negative influence Information only distorted my understanding of the		*Mostly negative* influence Information mostly distorted but slightly		*Moderately negative and moderately positive* Information moderately distorted and moderately clarified my		*Mostly positive* influence Information mostly clarified but slightly		*Only positive* influence Information only clarified my understanding of the

additional evidence.		clarified my understanding of the additional evidence.		understanding of the additional evidence.		distorted my understanding of the additional evidence.		additional evidence.

6. Overall, how objective do you feel you have been in approaching the evidence and making decisions about what happened and what caused the industrial accident?

○	○	○	○	○	○	○	○	○
Not at all objective		Slightly objective		Moderately objective		Highly objective		Extremely objective

7. Do you feel that the education you received about tunnel vision at the beginning of the study influenced your objectivity in this investigation study?

○	○	○	○	○	○	○	○	○
Education *definitely hindered* my objectivity		Education *slightly hindered* my objectivity		Education *did not influence* my objectivity		Education *slightly helped* my objectivity		Education *definitely helped* my objectivity

APPENDIX M

Study 2: Means and Standard Deviations

Table 8. *Undergraduate-Investigators' Cause Allocations at Time 1*

	Education					
	Control			TVE		
Bias	Worker Cause	Tire Cause	Other Cause	Worker Cause	Tire Cause	Other Cause
Unsafe Worker	66.62 (22.80)	23.97 (22.25)	9.40 (13.63)	54.69 (17.69)	29.69 (17.22)	15.63 (13.49)
Unsafe Tire	37.51 (25.90)	54.80 (26.16)	7.69 (8.69)	33.96 (23.26)	55.41 (27.38)	8.64 (11.35)
Total	52.07 (24.35)	39.39 (24.21)	8.55 (11.16)	44.33 (20.48)	42.55 (22.30)	12.14 (12.42)

Note: *N* = 136. Standard deviations in parenthesis.

Table 9. *Undergraduate-Investigators' Cause Allocations at Time 2*

	Education					
	Control			TVE		
Bias	Worker Cause	Tire Cause	Other Cause	Worker Cause	Tire Cause	Other Cause
Unsafe Worker	64.50 (21.72)	29.62 (17.07)	5.88 (9.12)	43.09 (27.44)	47.00 (28.26)	6.49 (9.71)
Unsafe Tire	45.66 (27.49)	47.86 (27.37)	9.91 (15.69)	59.64 (22.10)	32.76 (22.87)	6.43 (14.46)
Total	55.08 (24.61)	38.74 (22.22)	7.90 (12.41)	51.37 (24.77)	39.88 (25.57)	6.46 (12.09)

Note: *N* = 136. Standard deviations in parenthesis.

Table 10. *Undergraduate-Investigators' Confidence in their Cause Allocations at Time 1 and Time 2*

	Education				
	Control		TVE		
Time	Unsafe Worker	Unsafe Tire	Unsafe Worker	Unsafe Tire	Total
Time 1	69.56 (19.54)	73.41 (19.44)	61.67 (19.20)	62.58 (26.45)	67.32 (21.37)
Time 2	81.78 (14.03)	79.02 (14.63)	77.78 (15.33)	73.87 (22.90)	78.5 (16.69)
Total	75.67 (16.79)	76.22 (17.04)	69.73 (17.27)	68.23 (24.68)	72.91 (19.03)

Note: N = 153. Standard deviations in parenthesis.

Table 11. *Undergraduate-Investigators' Information Seeking at Time 1 and Time 2*

	Education				
	Control		TVE		
Time	Unsafe Worker	Unsafe Tire	Unsafe Worker	Unsafe Tire	Total
Time 1	5.80 (2.13)	5.37 (1.76)	6.81 (1.97)	6.71 (1.85)	6.10 (2.01)
Time 2	3.40 (1.90)	3.12 (1.72)	4.25 (1.93)	3.65 (2.07)	3.58 (1.93)
Total	4.6 (2.02)	4.25 (1.74)	5.53 (1.95)	5.18 (1.96)	4.84 (1.97)

Note: N = 153. Standard deviations in parenthesis. Likert scale: 7 = information is slightly adequate, some more information is needed; 5 = information is somewhat adequate, a little more information is needed; 3 = information is mostly adequate, more information would be nice but it is not needed

Table 12. *Information Undergraduate-Investigators Sought at Time 1*

	Education					
	Control			TVE		
Bias	Worker Info	Tire Info	Other Info	Worker Info	Tire Info	Other Info
Unsafe Worker	37.52 (20.29)	39.64 (16.22)	22.85 (20.14)	34.37 (17.12)	38,63 (17.26)	27.00 (19.85)
Unsafe Tire	42.32 (22.17)	41.61 (22.85)	16.07 (17.07)	40.65 (15.46)	42.90 (16.79)	16.45 (16.01)
Total	39.92 (21.23)	40.63 (19.53)	19.46 (18.61)	37.51 (16.29)	40.77 (17.03)	21.73 (17.93)

Note: *N* = 108. Standard deviations in parenthesis.

Table 13. *Information Undergraduate-Investigators Sought at Time 2*

	Education					
	Control			TVE		
Bias	Worker Info	Tire Info	Other Info	Worker Info	Tire Info	Other Info
Unsafe Worker	41.52 (26.41)	31.06 (22.94)	27.42 (32.77)	47.04 (26.94)	27.59 (21.23)	25.37 (23.49)
Unsafe Tire	48.46 (28.28)	32.07 (25.68)	19.46 (28.29)	57.00 (26.13)	24.75 (20.55)	18.25 (26.92)
Total	44.99 (27.35)	31.57 (24.31)	23.44 (30.53)	52.02 (26.54)	26.17 (20.94)	21.82 (25.21)

Note: *N* = 108. Standard deviations in parenthesis.

Table 14. *Undergraduate-Investigators' Ratings of the Support of the Additional Information*

	Education				
	Control		TVE		
Bias	Worker Evidence	Tire Evidence	Worker Evidence	Tire Evidence	Total
Unsafe Worker	5.22 (1.92)	6.27 (1.95)	5.61 (1.94)	5.92 (1.83)	5.75 (1.91)
Unsafe Tire	5.93 (1.89)	6.73 (2.04)	6.03 (1.83)	6.45 (1.48)	6.29 (1.83)
Total	5.56 (1.93)	6.49 (1.99)	5.81 (1.89)	6.16 (1.68)	6.02 (1.87)

Note: N = 153. Standard deviations in parenthesis. Likert scale: 5 = neutral; information did not support or discount what I originally determined, and 7 = supportive; information mostly reinforced what I had originally determined

Table 15. *Undergraduate-Investigators' Ratings of the Influence of the Unsafe Safety Report*

	Education					
	Control		TVE		Total	
Bias	Influence	Ben/Hind	Influence	Ben/Hind	Influence	Ben/Hind
Unsafe Worker	4.94 (1.59)	5.43 (1.35)	4.99 (1.02)	5.46 (0.93)	4.97 (1.36)	5.44 (1.17)
Unsafe Tire	5.48 (1.21)	6.05 (1.22)	5.49 (1.13)	5.94 (1.08)	5.49 (1.17)	6.01 (1.56)
Total	5.20 (1.44)	5.74 (1.32)	5.22 (1.09)	5.68 (1.02)	5.21 (1.29)	5.72 (1.19)

Note: N = 151. Standard deviations in parenthesis. Influence: Likert scale: 3 = slightly influenced, 5 = somewhat influenced, and 7 = highly influenced. Benefit/Hindrance (Ben/Hind): Likert scale: 5 = moderately negative/ moderately positive and 7 = mostly positive

APPENDIX N

Professional-Investigator Bias Manipulation Materials

Hypothesis Generation Exercise

- Before engaging in this study's industrial investigation we would like you to take part in a hypothesis generation exercise.
- We are interested in how effectively you can use limited information and hypothesize a *direct* cause of an industrial accident. On the following pages you will receive:

  1. **Background information about a tire man and a tire.**
  2. **Information about an industrial accident.**

- Once you have received this information you will be asked to generate a plausible explanation for the accident.

Example: Tire Unsafe Safety Report

TIRE

SAFETY REPORT
MARCH 2005 – MARCH 2008

SAFETY OVERVIEW

Tire Model: Michelin Model X1273

- Workplace safety evaluations indicate a poor safety history for this tire model.
- Although unverified, this tire model is suspected of causing 2 near misses (unplanned event that does not cause injury, damage or ill health but could do so) on the worksite in the last year.
- This tire model has been found responsible for 2 accidents in the last 3 years.
- The 2 accidents discussed above resulted in injury to 3 employees and cost the organization $20,000 in damages.

SAFETY PERFORMANCE MEASURE.

- The Safety Performance Measure is a tool used to assess the equipment's overall level of safety.
- This assessment measure takes into account a) the equipment's history of accidents and near misses within the organization, b) the equipment's history of accidents and near misses within other organizations, c) supervisor's performance reports of the equipment, and d) on-site workers' reviews of the equipment's safety.
- Scoring Criteria: Equipment's safety is scored on a scale of 0-100.

RESULTS: Tire: Michelin Model X1273:
Safety Performance Score = 9

Extremely Unsafe Score: 0-20	Unsafe Score: 21-40	Somewhat Safe Score: 41-60	Safe Score: 61-80	Extremely Safe Score: 81-100
X				

Special Note

- A Safety Performance Score of 9 typically results in elimination of the faulty equipment from the work site.
- Current organizational financial limitations demand that it be keep in use.
- The organization will terminate this tire model's use once financial pressures are alleviated in the next couple of months.

Example: Worker Neutral Safety Report

SAFETY REPORT
MARCH 2005 – MARCH 2008

TIRE MAN

SAFETY OVERVIEW

Tire man: Edward Price

- No notable incidents of unsafe behaviour in this tire man's work history.

SAFETY PERFORMANCE MEASURE.

- The Safety Performance measure is a tool used to assess an employee's overall level of safety.
- This assessment measure takes into account a) the employee's history of accidents and near misses within the organization, b) the employee's history of accidents and near misses within other organizations, c) supervisor's performance reports of the employee, and d) on-site workers' reviews of the employee's safety.
- Scoring Criteria: Employee's safety is scored on a scale of 0-100.

RESULTS:

Tire man: Edward Price:
Safety Performance Score = 50

Extremely Unsafe Score: 0-20	Unsafe Score: 21-40	Somewhat Safe Score: 41-60	Safe Score: 61-80	Extremely Safe Score: 81-100
		X		

Safety Report Quiz

According to the background information you just received in the Safety Reports:

1. How many accidents has the **tire** *(or tire man)* been responsible for in the last 3 years?				
0	2	10	14	25
2. What safety rating did the **tire** *(or tire man)* receive on the safety performance measure?				
Extremely Unsafe Score: 0-20	Unsafe Score: 21-40	Somewhat Safe Score: 41-60	Safe Score: 61-80	Extremely Safe Score: 81-100
3. What safety rating did the **tire man** *(or tire)* receive on the safety performance measure?				
Extremely Unsafe Score: 0-20	Unsafe Score: 21-40	Somewhat Safe Score: 41-60	Safe Score: 61-80	Extremely Safe Score: 81-100

Continue

Hypothesis Generation Exercise

Unsafe Tire Condition

- Please read the facts of the following industrial incident carefully.

Name of Person Reporting Incident [redacted]	Site *(business and location)* [redacted]			Incident No. [redacted]
Primary Type of Incident **Injury**	Severity Level			
Exact Location of Incident [redacted]	Date / Time of Incident [redacted]	Date Reported [redacted]	Date of Investigation [redacted]	
Facility Condition [redacted]				

- Tire man changed the tire on the work truck.
- At the beginning of the shift, the truck was moved to a sloped section of the worksite and parked diagonally on the hill.
- A worker was working in the bucket of the truck.
- The worker in the bucket noticed that the truck had an exaggerated lean.
- The truck then leaned sharply on the slope.
- The worker was unable to balance with the abrupt shift.
- The worker fell from the bucket down a steep embankment.
- This fall resulted in a significant worker injury. This injury led to an eventual amputation of the worker's leg.
- Findings indicate that the newly replaced truck tire was void of all air when examined at the accident site.

Imagine that you have done a thorough investigation of this incident and have considered all the evidence available. The evidence clearly indicates that the incident was a direct result of faulty equipment, specifically, a *substandard tire.*

Given your knowledge of the *tire* involved in this incident please describe how a *faulty tire* could have caused this accident:

Hypothesis Generation Exercise

Unsafe Tire Condition

- Please read the facts of the following industrial incident carefully.

Name of Person Reporting Incident [redacted]	Site *(business and location)* [redacted]	Incident No. [redacted]
Primary Type of Incident **Injury**	Severity Level	
Exact Location of Incident [redacted]	Date / Time of Incident [redacted]	Date Reported [redacted]	Date of Investigation [redacted]
Facility Condition [redacted]		

- Tire man changed the tire on the work truck.
- At the beginning of the shift, the truck was moved to a sloped section of the worksite and parked diagonally on the hill.
- A worker was working in the bucket of the truck.
- The worker in the bucket noticed that the truck had an exaggerated lean.
- The truck then leaned sharply on the slope.
- The worker was unable to balance with the abrupt shift.
- The worker fell from the bucket down a steep embankment.
- This fall resulted in a significant worker injury. This injury led to an eventual amputation of the worker's leg.
- Findings indicate that the newly replaced truck tire was void of all air when examined at the accident site.

Imagine that you have done a thorough investigation of this incident and have considered all the evidence available. The evidence clearly indicates that the incident was a direct result of substandard actions of the *tire man*.

Given your knowledge of the *tire man* involved in this incident please describe how the *substandard actions* of the *tire man* could have caused this accident:

APPENDIX O

Professional-Investigator Introductory Slideshow

Welcome to our Experiment

Next Slide →

Your Role

- Thank you for participating! It is only through industry professional's responses that we can understand decision making in the workplace investigation.
- In this study:
  - We would like you to determine what happened and what caused a workplace incident using your skills as a investigator.

Your Role

- The following slides contain a brief summary of what we mean when we ask:
  1) What happened during a workplace accident, and
  2) What caused the accident to happen.

What Happened vs. Causation

- What happened: Those things that happened during the incident.

  Example: Tom was walking through the shop and slipped on the water by the cooler.
- Causation: Those things that caused the accident to happen.

  Example: Tom slipped *because* a seal has broken in the cooler causing water leakage.

What Happened vs. Causation

Quiz

- Accident: Janet was climbing up the scaffolding when the rung she was holding onto broke. Janet fell and hit her head on the pavement. A review of the paperwork revealed that a crack had been observed in the rung that broke in the accident.
- What happened?
- What caused it?

What Happened

What is the best answer to what happened?

- A) Janet hit her head on the pavement.
- B) Janet was climbing up the scaffolding when the rung she was holding onto broke. Janet fell and hit her head on the pavement.
- C) The rung Janet was holding onto broke.

What Happened

✓ B) Janet was climbing up the scaffolding when the rung she was holding onto broke. Janet fell and hit her head on the pavement.

Causation

What is the best answer to what caused the accident?

- A) The rung Janet was holding onto broke.
- B) A pre-existing crack in the rung.
- C) A broken rung most likely caused by a pre-existing crack.

Causation

What is the best answer to what caused the accident?

✓ C) A broken rung most likely caused by a pre-existing crack.

Causation

- Our discussion of causation stops at what is considered a *direct cause*:
  - faulty equipment (a broken rung).
- Rather than a root cause:
  - poor maintenance.
- This on-line exercise is interested in direct causes.
- The following slides will outline in more detail what we mean by direct causes and root causes.

Direct Causes

- Direct cause:
  - A factor immediately responsible for the incident.
- *Direct* causes are:
  - A) Substandard Actions
    - E.g., worker fails to identify risk, uses equipment improperly.
  - B) Substandard Equipment
    - E.g., defective tools, equipment, or materials.
  - C) Substandard Environment
    - E.g., poor road conditions, weather conditions, noise, housekeeping.

Root Causes

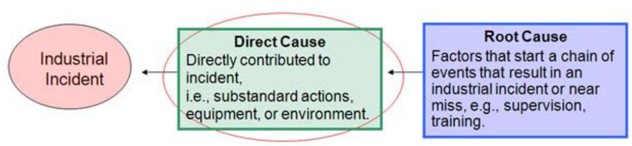
- Once you have determined direct cause(s) you must establish root cause(s).
- Root cause:
  - A factor that starts a chain of events that results in an industrial incident or near miss.

- *Root* causes are:
  - Personal Factors
    - E.g., employee stress, lack of knowledge/skill.
  - Job/System Factors
    - E.g., management, inadequate supervision, inadequate maintenance.

Example

Event: Car will not start

- *d*: battery is dead ← Direct Cause
- *c*: alternator does not function
- *b*: alternator is well beyond its designed service life
- *a*: car is not being maintained ← Root Cause



Your role in this on-line study:

- Industrial investigations are complex and require a great deal of information.
- Our simulated investigation does not provide you with enough information to establish the root causes of the incident.

- In the exercises that follow simply indicate the *direct cause(s)* involved in the incident rather than the root causes.

What is your Job?

- Your job over the next 40 minutes is to:

  I) determine what happened in the industrial incident,

  II) determine the direct cause(s) of an incident.

What is your Job?

- The case information that you are going to read was a true incident.
- To ensure anonymity we have omitted identifying information and changed the format of some of the information you are receiving.

Bonus

- In addition to the $6 Amazon gift certificate you will receive for participating, if you are correct in the your investigative conclusions, you will also be entered into a draw to win **$100**.
- Good Luck!

APPENDIX P

Professional-Investigator: Investigative Findings Questionnaire 1 and 3

Investigator Questionnaire 1

1. Please describe, in as much detail as possible, what happened in the accident:

2. What do you think could have caused the accident:

3. Rate your confidence on a scale of 0-100 in your response to question 2.

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

4.
Direct Cause Allocation

Recall that *direct causes* are the immediate causes of the incident, i.e., inappropriate actions, faulty equipment or a substandard working environment (not root causes e.g., inadequate supervision or training, employee stress, poor maintenance).

Please distribute 100% of the cause of this incident in the following three direct cause(s) (e.g., 10, 60, 30 or 80,10,10):

Substandard Tire Man Action
Substandard Tire
Other Substandard Factors (i.e. equipment, action, or environment):

5. Rate your confidence on a scale of 0-100 in the accuracy of the *direct cause allocation* you proposed in question 4.

○	○	○	○	○	○	○	○	○	○	○
0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

6. If you were to stop right now, do you feel you have an adequate amount of information to reach a conclusion about the *direct cause(s)* of the accident?

○	○	○	○	○	○	○	○	○
Information is *adequate*: No more information is needed.		Information is *mostly adequate*: More information would be nice but it is not needed.		Information is *somewhat adequate*: A little more information is needed.		Information is *slightly adequate*: Some more information is needed.		Information is *not adequate*: Far more information is needed.

7. Of the new information that you require please indicate what type of information you would seek by allocating 100% of your new information into the following three categories.

☐ Tire Information: (indicate the tire information you would find helpful below)

☐ Tire Man Information: (indicate the worker information you would find helpful below)

☐ Other Information: (indicate the other information you would find helpful below)

Investigator Questionnaire 3

Your investigation is now complete and it is time for you to provide your final conclusions about what caused the industrial accident. Please take your time as your eligibility in the $100 draw is based on these conclusions.

1. Please describe, in as much detail as possible, what happened in the accident:

2. What do you believe *caused* the accident?

3. Rate your confidence on a scale of 0-100 in the cause of the accident proposed in question 2.

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

4. Direct Cause Allocation

   Recall that *direct causes* are the immediate causes of the incident, i.e., inappropriate actions, faulty equipment or a substandard working environment (not root causes e.g., inadequate supervision or training, employee stress, poor maintenance).

   Please distribute 100% of the cause of this incident in the following three direct cause(s) (e.g., 10, 60, 30 or 80,10,10):

   Substandard Tire Man Action
   Substandard Tire
   Other Substandard Factors (i.e. equipment, action, or environment):

5. Rate your confidence on a scale of 0-100 in the accuracy of the *direct cause allocation* you proposed in question 4.

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

6. Do you feel you had an adequate amount of information to reach a conclusion about *what directly caused* the accident?

Information is *adequate*: No more information is needed.		Information is *mostly adequate*: More information would be nice but it is not needed.		Information is *somewhat adequate*: A little more information is needed.		Information is *slightly adequate*: Some more information is needed.		Information is *not adequate*: Far more information is needed.

7. Of the new information that you require please indicate what type of information you would seek by allocating 100% of your new information into the following three categories.

Tire Information: (indicate the tire information you would find helpful below)

Tire Man Information: (indicate the worker information you would find helpful below)

Other Information: (indicate the other information you would find helpful below)

8. Using the following scale of 0 - 100, rate your confidence that you are going to be entered in the draw to win $100 as a result of your investigative conclusions (i.e., your written statement of what happened, your conclusion of what caused the event and your final cause allocation).

0 % **Not at all Confident**	10 %	20 %	30 %	40 %	50 % **Moderately Confident**	60 %	70 %	80 %	90 %	100 % **Extremely Confident**

APPENDIX Q

Study 2: Means and Standard Deviations

Table 17. *Professional-Investigators' Cause Allocations at Time 1*

	Education					
	Control			TVE		
Bias	Worker Cause	Tire Cause	Other Cause	Worker Cause	Tire Cause	Other Cause
Unsafe Worker	68.75 (12.45)	15.83 (9.25)	15.42 (14.06)	31.83 (21.55)	32.00 (12.85)	36.17(13.39)
Unsafe Tire	26.36 (26.28)	50.91 (29.14)	22.73 (15.06)	40.60 (21.33)	28.60 (18.25)	30.80 (22.67)
Total	47.56 (19.37)	33.37 (19.20)	19.08 (14.56)	36.22 (21.44)	30.30 (15.55)	33.49 (18.03)

Note: N = 39. Standard deviations in parenthesis.

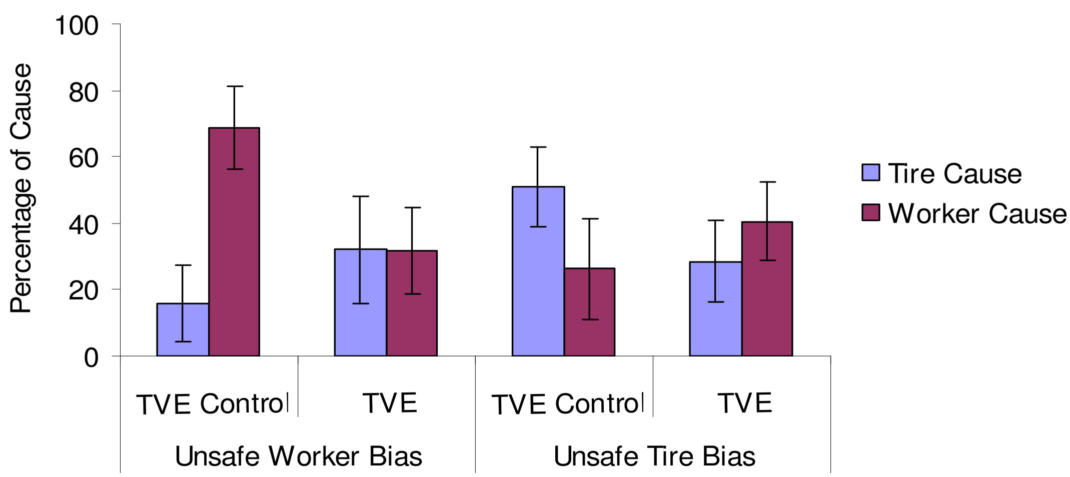


Figure 7. Professional-investigator: Cause allocation, bias and education at time 1. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

Table 18. *Professional-Investigators' Cause Allocations at Time 2*

	Education					
	Control			TVE		
Bias	Worker Cause	Tire Cause	Other Cause	Worker Cause	Tire Cause	Other Cause
Unsafe Worker	61.25 (25.06)	20.00 (21.74)	18.75 (13.67)	34.83 (24.03)	34.17 (13.82)	31.00 (11.49)
Unsafe Tire	45.45 (29.11)	36.36 (28.73)	18.18 (17.22)	52.60 (19.75)	23.00 (12.88)	24.40 (15.22)
Total	53.35 (27.09)	28.18 (25.24)	18.47 (15.45)	43.72 (21.89)	28.59 (13.35)	27.70 (13.36)

Note: N = 39. Standard deviations in parenthesis.

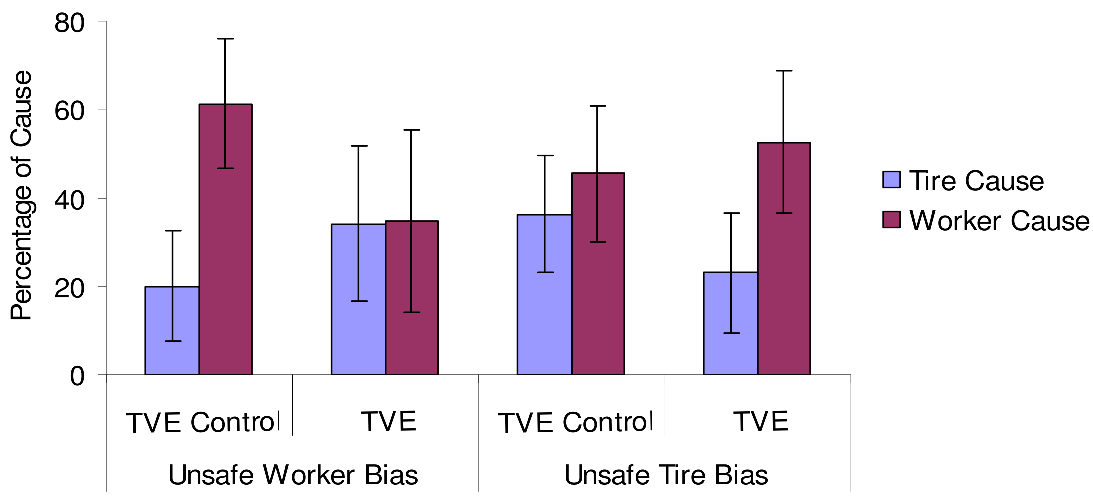


Figure 8. Professional-investigator: Cause allocation, bias and education at time 2. Error bars represent the 95% between-subjects confidence intervals based on the standard error of the mean.

Table 19. *Professional-Investigators' Confidence in their Cause Allocations at Time 1 and Time 2*

	Education				
	Control		TVE		
Time	Unsafe Worker	Unsafe Tire	Unsafe Worker	Unsafe Tire	Total
Time 1	74.17 (21.09)	70.00 (23.66)	70.00 (22.80)	67.00 (30.20)	70.51 (23.84)
Time 2	82.50 (18.65)	72.73 (14.89)	48.33 (39.20)	73.00 (34.01)	72.05 (27.55)
Total	78.34 (19.87)	71.37 (19.28)	59.17 (31.00)	70.00 (32.11)	71.28 (25.70)

Note: N = 39. Standard deviations in parenthesis.

Table 20. *Professional-Investigators' Information Seeking at Time 1 and Time 2*

	Education				
	Control		TVE		
Time	Unsafe Worker	Unsafe Tire	Unsafe Worker	Unsafe Tire	Total
Time 1	6.08 (3.00)	6.45 (2.42)	7.33 (3.20)	8.50 (0.85)	7.00 (2.58)
Time 2	4.25 (2.80)	5.27 (2.45)	6.00 (3.52)	6.70 (2.11)	5.44 (2.73)
Total	5.17 (2.90)	5.86 (2.44)	6.67 (3.36)	7.60 (1.48)	6.22 (2.66)

Note: N = 39. Standard deviations in parenthesis. Likert scale: 7 = information is slightly adequate, some more information is needed; 5 = information is somewhat adequate, a little more information is needed; 3 = information is mostly adequate, more information would be nice but it is not needed.

Table 21. *Information Professional-Investigators Sought at Time 1*

	Education					
	Control			TVE		
Bias	Worker Info	Tire Info	Other Info	Worker Info	Tire Info	Other Info
Unsafe Worker	46.25 (19.04)	24.38 (20.08)	29.38 (16.13)	27.50 (15.54)	27.50 (8.66)	45.00 (23.81)
Unsafe Tire	35.90 (17.51)	42.30 (25.16)	21.80 (15.85)	29.40 (7.06)	33.40 (13.07)	37.20 (13.66)
Total	41.08 (18.28)	33.34 (22.64)	25.59 (15.99)	28.45 (11.30)	30.45 (10.87)	41.10 (18.74)

Note: N = 32. Standard deviations in parenthesis.

Table 22. *Information Professional-Investigators Sought at Time 2*

	Education					
	Control			TVE		
Bias	Worker Info	Tire Info	Other Info	Worker Info	Tire Info	Other Info
Unsafe Worker	23.75 (13.56)	40.63 (28.21)	35.63 (26.52)	36.25 (9.25)	23.25 (16.09)	40.50 (20.08)
Unsafe Tire	44.00 (23.66)	32.50 (22.02)	23.50 (17.96)	32.60 (11.06)	36.10 (19.06)	31.30 (21.83)
Total	33.88 (18.61)	36.57 (25.12)	29.57 (22.24)	34.43 (10.16)	29.68 (17.58)	35.90 (20.96)

Note: N = 32. Standard deviations in parenthesis.

Table 23. *Professional-Investigators' Ratings of the Support of the Additional Information*

	Education				
	Control		TVE		
Bias	Worker Evidence	Tire Evidence	Worker Evidence	Tire Evidence	Total
Unsafe Worker	6.42 (1.93)	6.58 (1.17)	6.33 (1.03)	5.67 (1.63)	6.25 (1.44)
Unsafe Tire	5.82 (1.83)	5.91 (1.70)	5.90 (1.20)	6.20 (1.03)	5.96 (1.44)
Total	6.13 (1.87)	6.26 (1.45)	6.06 (1.12)	6.00 (1.27)	6.11 (1.43)

Note: N = 39. Standard deviations in parenthesis. Likert scale: 5 = neutral; information did not support or discount what I originally determined, and 7 = supportive; information mostly reinforced what I had originally determined

Table 24. *Professional-Investigators' Ratings of the Influence of the Unsafe Safety Report*

	Education					
	Control		TVE		Total	
Bias	Influence	Ben/Hind	Influence	Ben/Hind	Influence	Ben/Hind
Unsafe Worker	3.40 (2.10)	5.84 (1.83)	2.67 (1.94)	7.00 (2.31)	3.15 (2.02)	6.23 (1.98)
Unsafe Tire	4.86 (1.51)	6.25 (0.96)	3.28 (1.29)	5.06 (1.51)	4.11 (1.60)	5.68 (1.37)
Total	4.10 (1.95)	6.08 (1.36)	3.05 (1.53)	5.61 (1.91)	3.67 (1.85)	5.96 (1.68)

Note: N = 39. Standard deviations in parenthesis. Influence: Likert scale: 3 = slightly influenced, 5 = somewhat influenced, and 7 = highly influenced. Benefit/Hindrance (Ben/Hind): Likert scale: 5 = moderately negative/ moderately positive and 7 = mostly positive