# SAFETY CLIMATE AND AFTER-ACTION REVIEWS IN THE FIRE SERVICE

by

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# ABSTRACT

DANIEL LORENZO BONILLA. Safety climate and after action reviews in the fire service. (Under the direction of DR. CLIFTON SCOTT)

Research on safety climate has focused on supervisor attitudes and their relationship to the attitudes of their direct reports. This study examined the relationship of supervisor behaviors on direct report attitudes that in turn affect group level safety climate among firefighters. This study aggregated perceptions of supervisor trust, leader-member exchange, behavioral integrity, supervisor after action review behavior, and safety climate to the group level to examine the relationship between supervisor behaviors, direct report attitudes and group safety climate. This study found that supervisor trust, behavioral integrity, and supervisor after action review behaviors have a strong positive relationship to safety climate. Further, perceptions of trust partially mediate the relationship between supervisor after action review behaviors and group level safety climate. Future research ideas, theoretical advancements, and practical applications are discussed.

# DEDICATION

This paper is dedicated to my parents, Pedro and Patricia Bonilla. Their support and dedication to my education is greatly appreciated. I can only hope I have made them proud of my accomplishments. I would not be in this position today without their unconditional love. They pushed me to never settle for average.

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# STATEMENT OF THE PROBLEM

The costs of workplace injury and death are incredibly high. There were over 3.2 million nonfatal workplace injuries and illnesses in the private sector in 2009(US Department of Labor's Bureau of Labor Statistics). In the same year there were 4,340 fatalities across all private sectors. This statistic has held steady between 3,500 and 5,000 deaths per year over the past ten years according to data recorded by the US Department of Labor.

These data, however, are not the entire story. According to Brown (2011) the Department of Labor, as part of the Occupational Safety and Health Act (OSHA), only records private sector injury data. There are roughly 19 million government employees who are not included in the above statistics. Brown (2011) reported that these employees actually had a higher rate of injury than private sector employees in 2008. For example, firefighters had the highest rate of nonfatal injury in 2008 at 14.8 injuries per 100 employees. In that same year the entire public sector experienced 6.3 nonfatal injuries per 100 employees. Both are higher than the private sector in 2008.

Leigh, Markowitz, Fahs, & Landrigan (2000) attempted to calculate the direct and indirect cost of workplace injury and death in 1992. Using statistics from the Department of Labor, the National Health Interview Survey, the Bureau of Labor Statistics Census of Fatal Occupational Injuries, and other sources the researchers estimate that there were 6,371 fatal workplace injuries in 1992 and over 13 million nonfatal injuries.

Leigh, et al. (2000) estimated $155.5 billion in direct and indirect costs to employees, employers, and taxpayers in 1992 due to workplace injury, assault, and death across private and public sectors. In short, the costs of workplace injury, direct and

indirect, financial and physical, are enormous. Leigh, et al. (2000) estimated that most Americans between the ages of 22 and 65 spend nearly half of their waking hours at work. The risk here is quite large. Statistically speaking, the workplace is much more dangerous than the average household and the costs associated with workplace injury and death are higher than that of AIDS, arthritis, or Alzheimer's disease on a national level (Leigh, et al., 2000).

Considering these incredible costs, workplace safety should be at the top of most executive's agendas when examining organizational risk. In many cases it is. In accordance with OSHA, employers and employees must comply with a variety of safety regulations or face stiff penalties and fines. Brown (2011) found that organizations with an explicit safety program in 2008 experienced a lower rate of employee injury than organizations lacking such a program. Focusing on safety is a wise risk management decision on an organizational level. It is also a wise ethical decision. Communities and individual lives are at risk when organizations do not prize safety. Risk management is something organizations ought to do.

A variety of approaches have been taken to address organizational safety. Mandating OSHA compliance (Brown, 2011), linking safety performance to pay (Collinson, 1999), and using behaviorally based safety programs (Williams & Geller, 2000) have all seen some (limited) success in reducing the number of workplace injuries. Each approach works to a certain extent but also presents unforeseen challenges.

For example, mandating OSHA compliance usually means creating an environmental health and safety department within an organization to enforce punishments for unsafe workplace behavior. Unfortunately, this means the department

can be seen as too punitive and can be resented. Employees may begin hiding unsafe workplace behaviors rather than not engaging in safe behaviors.

To avoid this issue, organizations may take a less punitive approach and (instead of punishing unsafe behaviors) reward safe workplace behaviors. For example, work groups may be compensated for maintaining a low injury rate. The logic here is that groups with a low injury rate should be engaging in safe behaviors. Unfortunately, this has been shown to lead to underreporting of accidents and injuries; what has been called impression management by concealment (Collinson, 1999). In this case the problem is placing a focus on outcome metrics rather than process dynamics. That is, rewarding an outcome (such as a low number of accidents) without any regard to how that was accomplished. Hofmann & Stetzer (1996) discuss the importance of focusing on process over outcome in their paper on factors influencing unsafe behaviors. They argue that focusing on outcomes only leads to employees taking shortcuts. In short, linking safety performance to pay encourages unintended and unsafe behaviors.

To circumvent this issue some organizations have implemented behaviorally based safety programs (DePasquale & Geller, 1999; Williams, & Geller, 2000). Behaviorally based safety programs are defined as programs that attempt to track safety processes along with safety outcomes. That is, bringing a focus onto the behaviors that should lead to reduced workplace injury as opposed to tracking behaviors that are deemed as unsafe work practices. For example, tracking (and rewarding) open safety discussion, following proper lock out/tag out protocol (a common safety technique in organizations that use large machines), and “catching” employees being safe. That is,

conducting audits that reward good safety behaviors rather than punishing poor safety behaviors.

This approach has seen some success (Williams & Geller, 2000) and is generally favored by employees (DesPasquale & Geller, 1999). However, this approach alone is not enough. It assumes a level of trust between front line employees and their direct supervisors (Geller, 1998), and (most importantly) shared organizational attitudes and norms about what safety is and to what degree it is valued. For example, DesPasquale & Geller (1999) found qualitative evidence in focus groups that a lack of buy-in from supervisors and peers can quickly derail a behaviorally based safety program. Williams & Geller (2000) argue that trust is the ingredient missing from most behaviorally based safety programs. Without trust shared norms cannot be created, and without those shared norms safety cannot be reached. Trust and safety lead to what is called safety culture. A strong safety culture is a key antecedent to safe behaviors and reduced accidents, injuries, and death (Hofmann & Morgeson 1999; Hofmann & Stetzer, 1998; Zohar, 2010).

These concepts are of the utmost importance in high reliability organizations (HROs). These are organizations operating in high risk and unpredictable environments that strive for, and reach, safety and reliability in operations (Roberts & Rousseau, 1993). HROs are a subset of high risk organizations. Both operate in dangerous environments yet HROs manage to mitigate nearly all of the risk they encounter. What we learn from these organizations that operate in high risk environments can be generalized to other organizations (Weick, Sutcliffe, & Obstfeld, 1999). If they can manage to operate reliably perhaps we can learn from their practices.

Practically speaking, this dissertation will focus on the relationships between one type of safety enhancing intervention (after action reviews) on safety climate. I will examine the attitudinal and behavioral variables associated with after action reviews and their relationship to safety climate. There will be a special focus on leadership, trust, supervisor behaviors, and perceived behavioral integrity. Taken together these variables focus on what group leaders can do to enhance the safety climate of their group.

Of interest to practitioners in the safety space this dissertation will inform after action review leadership and its relationship to safety climate. It is already clear that after action reviews have a strong relationship to safety climate (Allen, Baran, & Scott, 2001). However, the specific reasons- the actual behaviors- that make for the most effective after action reviews are still up for debate. This dissertation ought to help inform that discussion and move it forward by measuring supervisor behaviors and assessing their relationship to safety climate.

The relationship between trust, behavioral integrity, and safety climate is an unexplored yet vitally important area of research. In his paper on the future of safety climate, Zohar (2010) writes that behavioral integrity is a new and exciting direction in which to take safety climate research. This is because theory suggests it is a mechanism to leverage change in safety climate. Shared attitudes like safety climate can be difficult to change, especially when they have become entrenched over time. The idea that perceptions of one individual can affect shared safety attitudes is exciting because it provides an easier target for change. Describing what a supervisor can do to be perceived as more trustworthy (and be perceived as having more behavioral integrity) can truly help improve safety norms. Thus, a study critically examining the relationships

betweenperceived supervisor trust, behavioral integrity, and supervisor behaviors on safety climate is valuable for theory.

This type of information would be important in practice as well. Imagine a supervisor based behavioral best practices list for improving safety climate. Links could be made between one individual's behavior and the accident rate of their team. Lives could be saved, accidents reduced, and employees could work in healthier environments. The connections between trust, behavioral integrity, AARs, and safety climate are vital to the high risk industry. This dissertation will attempt to make those first connections between these important constructs.

# SAFETY CLIMATE AND SAFETY CULTURE

Weick (1987) argues that understanding organizational safety is really an issue of control. It is a balancing act between giving autonomy to organizational members and still ensuring that appropriate safety rules are being followed. That is, how can management get all employees to work safely without inundating them with a constant stream of safety micro-management? Micromanagement is a poor practice because it limits the flexibility of individuals and the organization. This flexibility is vital for high risk organizations. They need to be able to react to incidents as soon as they are perceived. In high risk organizations being slow to act can be fatal (Weick, 2001). Weick (1987) says that organizational culture is a way to enact centralized control via norms and attitudes (which are process and product of communicative interaction) while still enjoying the benefits of decentralized organizational structure.

In the case of safety, culture acts as a tool to keep all employees "on the same page" without over-constraining their behavior (Boin & Schulman, 2008; Bierly & Spender, 1995; Weick, 1987). This means that employees share the same deeply rooted underlying assumptions about how work is done. Weick argues that this is absolutely integral to maintaining reliability in high risk organizations. Safety culture goes beyond external motivators for safe behavior such as OSHA penalties, safety outcome rewards, and behaviorally based safety programs and creates an internal motivator for safe behaviors; one that is continuously reflected and reinforced via interaction among members as they strive to make sense of shifts in organizational environments (Scott & Trethewey, 2008). If organizational members truly value safety by enacting and

sustaining a culture that emphasizes its importance, then it will show up in their workplace behaviors. Safety culture is a tool used to reinforce that value.

Safety climate, on the other hand, is a measurable component of safety culture. Defined as the shared norms and attitudes concerning the relative importance of safety within an organization (or work group) symptomatic of an organization's safety culture (Zohar, 2008). It is a surface feature of safety culture (Mearns & Flin, 1999) that can be manipulated (Denison, 1996) through organizational initiatives (behaviorally based safety programs, for example). It is logical to assume that the state of safety climate is somewhat indicative of the state of safety culture. A later section will discuss safety climate in more detail.

## Safety as a Social Construction

Although they are associated with objective organizational outcomes (e.g., mortality statistics, insurance costs), safety and danger are each intersubjective, negotiated social constructions (Turner & Gray, in press). Simpson (1996) argues that "in safety there is always the possibility that danger lurks unseen" (pg. 551). Because safety and danger are emergent and often misunderstood, there are no clear, objective, and consistent warning signs of safety (or danger). Because organizations are ultimately fallible entities, employee's interpretations of risk and safety are often poor. To treat them as objective would only serve to invite even more unintended risk. What we consider to be dangerous depends on what we (as a group, organization, society, etc.) habitually label as dangerous. This is because we, as humans, rarely have all pertinent information about a situation and we could not process all of this information even if we did. However, we still draw conclusions about a given situation and act on them.

Weick (2001) provides an excellent example of this in his chapter on the Mann Gulch disaster. He describes smokejumpers (forest firefighters) sent into a blaze to put it out. Due to the smoke and sound of the fire around them they were unable to verbally communicate with each other. The wind changed and suddenly the fire was coming towards them. One smokejumper was able to assess this information accurately and began creating an escape fire. However, he was unable to communicate his new information (that the wind changed and the fire was coming towards them) and his behavior seemed bizarre to on-looking smokejumpers (creating an escape fire was not standard procedure in the fire service at the time). By the time the rest of the team realized that the fire was coming towards them it was too late.

What was collectively assessed as safe by most of the smokejumpers was assessed as dangerous by one unable to communicate his opinion. In either case, the label of "safe" and "dangerous" is a subjective one. There is no doubt that I would label being near any type of wild fire as dangerous regardless of wind speed or direction while some smokejumpers may label it as safe (and still others as dangerous for different reasons).

What "counts" as safe is the product of a shared negotiated consensus. Here "negotiated" means "a set of ongoing processes (intentional and unintentional) through which knowledgeable individuals…engage, disengage, and accomplish reciprocal…influence over the intended meanings for participation in organizational functions" (Scott & Myers, 2010, pg. 80). Negotiated meaning is a function of individuals, their perceptions, and the process by which they communicate. Individuals differ as do their perceptions and communicative processes. More importantly, groups

differ in their shared perceptions. It is through interaction with one's unique group that safety and danger are negotiated.

What works on a group level could also be brought up to the organization. What is discussed at one organization may not be discussed at another. Thus, the definition of safety and how safety is understood as relating to membership (and therefore safety and danger itself) must vary between organizations. These organizations are made up of different people in different groups with different shared attitudes.

## Organizational Culture and Sensemaking

The way a group defines safety in a given situation is a product of retrospective sensemaking. Retrospective sensemaking is a shared and dynamic process (Weick, 2001) through which individuals communicate with each other to make sense of their shared experiences with plausible interpretations and meaning. In reliability seeking organizations retrospective sensemaking is a powerful tool, as it can help to reduce ambiguity (Allen, et al, 2010) about dangerous situations turning them into learning opportunities.

Poor sensemaking has negative consequences as well. Consider the plausible explanations that allowed the Challenger and Discovery shuttles to launch. In both cases a possible error was found (faulty O-rings in the Challenger, the Discovery shedding parts of its hull during take-off) and considered unimportant to safety. The meaning behind weak O-rings, for example, was that it was within a margin of error (Boin & Schulmann, 1998). As Vaughan (1996) argues in her book on the Challenger disaster, NASA decision makers stopped using an engineering technical viewpoint and instead took the point of view of managers. This meant that risk previously considered

intolerable was suddenly within acceptable limits for a launch. The managerial point of view is plausible because as Simpson (1996) argues risk is always lurking. There is simply no way to launch a space shuttle with zero risk. Instead, an acceptable level of risk must be taken. The managerial viewpoint simply accepts a higher level of risk than the engineering technical viewpoint.

History tells us that this was a mistake. The wrong framework was used to launch the shuttle. Appropriate sensemaking could not occur. In short, retrospective sensemaking is the process of creating, sharing, and retaining narrative frameworks that sustain lessons and interpretations about safety and reliability. These lessons go on to shape organizational members' interpretations of risk and safety in the workplace. Ideally, these interpretations are accurate and shared.

For example, Weick (1987) argues that storytelling is a mechanism by which culture promotes reliability. Indeed, the idea of stories and myths as tools of organizational culture has been successfully used before to study culture (Browning, 2006; Martin, 1992). Weick (1987) proposes that culture allows an organization to centralize assumptions and attitudes while still allowing individuals to act in decentralized ways. This allows for some centralized control (which reduces some type of risk and liability) while still allowing for the decentralized autonomy of employees (which lets employees see novel errors before they grow to be catastrophic). These assumptions and attitudes that are shaped by culture are social constructions of reality. Says Weick, "Making meaning is an issue of culture" (1987, pg. 123). Thus, retrospective sensemaking as a cultural tool creates meaning about safety in high risk

organizations.AARs are a venue where group members share interpretations and attempt to develop and retain them through a shared narrative.

In his article on the subject, Weick (1987) states that culture "creates a homogenous set of assumptions and decision premises which… preserve coordination" (pg. 124). However, this assumes that organizational culture is a large, looming, and unified structure that affects all organizational members in a consistent way. Considering the size and complexity of modern organizations, this assumption seems questionable because the larger and more complex an organization, the more difficult it is to maintain a unified culture. Gherardi, Nicolini, & Odella (1998), for example, argue that definitions of safety and danger can vary within organizations. Their major finding is that organizational culture as a unitary and unchanging construct is false. This is interesting considering that is in contrast to traditional organizational culture research. Schein (1992), for example defines organizational culture as deeply held largely unconscious assumptions and beliefs that are shared among all organizational members. He argues that the most fundamental aspects of culture are shared among all members.

This same assumption (articulated or not) appears in other definitions of culture. Roussea (1990) created a five layer model of organizational culture. The top layer is the most accessible and is made up of organizational branding and logos. As the layers go deeper they become less accessible. Behavioral patterns give way to behavioral norms. These, in turn, give way to values and beliefs. Finally, the deepest layer is made up of shared assumptions outside of conscious awareness. These are the most difficult to assess and are assumed to be shared among all organizational members. In both Schein's (1992) and Roussea's (1990) theories, organizational culture is assumed to be unified.

Instead, Gherardi, et al. (1998) argue that organizational culture (specifically safety culture) is negotiated and shared among groups or communities of practice within an organization (rather than the organization as a whole). In a large organization, consensus cannot be reasonably expected among all employees, especially when these employees spend their time organizing, negotiating, and making sense of the environment intersubjectively with their own work group. Their basic assumptions (conscious or not) may be shared within their work group with whom they interact with on a consistent basis. However, it seems unlikely that these assumptions would be shared organization-wide.

Assuming that organizational culture is not unified, Martin & Meyerson (1988) provided a three part taxonomy of organizational culture. These are an "integrated" culture, a "differentiated" culture, and a "fragmented" culture. These move from most unified in culture to least unified. They argue that most organizations cannot have an integrated and unitary culture and instead fall into the category of "differentiation" or "fragmentation." A differentiated culture is one in which subcultures form. These subcultures can coexist harmoniously or be in conflict. However, there is often some level of agreement within the subculture. A fragmented culture is one in which ambiguity reigns supreme. Events can be interpreted in many ways and clear consensus cannot be attained among subcultures. Considering the ambiguous, complex, and dangerous environments in which reliability seeking organizations operate (Roberts & Rousseau, 1989), it is likely that an organization's safety culture can be characterized by fragmentation or differentiation. Both acknowledge the role of ambiguity within the

organization and make room for consensus (or attempts at consensus building) within the work group.

Choudhry, Fang, & Mohamed (2007) argue that safety culture should be examined on a subculture or departmental level. They see it as counterproductive to work towards an overall organizational safety culture and to instead accept the fact that natural groups within the organization will have their own sets of shared attitudes, assumptions, values, and beliefs concerning safety. Thus, it makes sense that the unit of analysis for safety culture should not be the organization, but rather the work group. Organizational safety culture is too broad a tool to be useful. Instead, group safety culture is the most logical unit of analysis. It is with the group that employees communicate primarily. It is with the group that employees socially construct the meaning of safety and hazards (Simpson, 1996) and engage in retrospective sensemaking. Thus, it is in the group that we should examine shared, communicatively enacted cultural artifacts.For example, consider Scott & Trethewey's (2008) study of firefighters. They found that firefighters accentuate and attenuate certain aspects (concerning safety) of the environment to preserve a certain sense of self. That is, they bring to light and place an importance on some aspects of their environment while brushing over other aspects. They engage in sensemaking on the group level.

Firefighters work in separate crews with relatively stable membership and supervisory status. The general aspects of the environment that are accentuated and attenuated may be shared across crews; however, the specific aspects likely are not. Firefighting crews experience their environment (and subsequently make sense of it) with members of their own crew, not necessarily with all other crews. Thus we would expect

there to be within group consistency and between group variations in each crews' interpretations of hazards and safety because they are accentuating and attenuating different environmental aspects.

Scott & Trethewey (2008) provide evidence of both 1) the idea that safety and danger are socially constructed and 2) that this construction can and does occur on the group (or subculture) level. Collinson (1999) also shows qualitative evidence of this phenomenon when studying oil rig workers. In his study, the employees on the oil rigs (which are out at sea) and upper management (whose offices are located on land) created different meanings for the organizational practice of linking a group's safety record to pay. To upper management linking one's safety performance record to their pay created a culture of accountability and safety. To the employees on the rigs it created a culture of "us vs them" where it was assumed that small accidents would go unreported because employees didn't want to lose pay. The same seemingly objective stimuli (linking safety performance to pay) reflected and sustained divergent attitudes and values among different subgroups within the organization.

Of course, cultural messages from the organization (as opposed to the work group) can affect a group's shared social construction. However, it makes sense to assume that how these messages are perceived is mediated by group level interpretations. Zohar & Luria (2005) conducted a hierarchical analysis supporting the idea that group safety climate is nested within organizational safety climate. Ultimately, the largest amount of variance in predicting actual accident rates was claimed by group, not organizational, safety climate. Allen, et al. (2010) also reported that group safety climate had a stronger relationship with safety outcomes than organizational safety climate,

although their study was not hierarchical. This makes sense. One's immediate group should have a stronger relationship to shared group attitudes than the larger organization in which the group is nested.

## Safety Climate

Zohar (2010) provides a different name for the socially constructed negotiation of what aspects of the environment the group considers safe or dangerous- group safety climate. He defines group safety climate as the shared attitudes about the relative importance of safety within a work group. Denison (1996) describes the difference between culture and climate. He argues that climate refers to a situation and its link to thoughts, feelings, and behaviors of organizational members. Culture, in contrast, refers to a context (within which a situation may be embedded). Culture is rooted in history which is collectively held and sufficiently complex to resist many attempts at direct manipulation.

He goes on to identify other differences between culture and climate. One important distinction is the relationship between the individual and the culture or climate in which they are embedded. Climate research focuses more on the effect of a specific climate on the individual (or group of individuals) rather than the creation of a climate by individuals. Culture research, alternatively, is focused on the creation of the social context by organizational members. This distinction is likely due to the theoretical foundation of climate research. Lewin (1951) argues that behavior is a function of the interaction between the individual and the environment. That is, the individual is separate from the environment. This is a logical framework if you are interested in the effect of

climate on organizational members. It is quite problematic if you are interested in the way organizational members create (and then are affected by) their own culture.

Further, Denison (1996) identifies different epistemologies for culture and climate. Climate comes from a positivist background as evidenced by the quantitative approach often used to study it. Culture, on the other hand, takes a post-modern perspective which, as a fundamental characteristic, does not allow variable analytic comparisons as a way to uncover truth. Because all experience is relative and subjective (according to post-modern scholars) it would not make sense to study and compare different organizational cultures or dimensions of culture. It implies values on categories that the researcher cannot possible know. Thus, culture researchers often use qualitative methods to get at the "deep structure of the organization…which is rooted in values, beliefs, and assumptions…where meaning is created through socialization…and interaction reproduces a symbolic world" (Denison, 1996, pg. 624).

Mearns & Flin (1999) examine the specific case of safety culture and climate. They conclude that safety climate can be regarded as a surface feature of safety culture. The important distinction for my study is the concept of manipulation. If attitudes about the relative importance of safety on the group level are intersubjective and negotiated then they are, by definition, changeable. Culture, as described by Denison (1996) and Mearns & Flin (1999) seems to be more of a static construct (or at least slower changing). Choudhry, et al. (2007) echo these researchers and argue that safety climate is a measurable product of safety culture. This is the theoretical approach that will be used for the current study. Thus, as a researcher I land closer to the positivist (rather than interpretive) tradition with some reservations. I assume that the shared attitudes measured

by quantitative measures of climate are appropriate for comparison across groups and organizations. However, I acknowledge that climate is a merely a component embedded within a larger cultural context. The entirety of the cultural context would require extensive qualitative inquiry. Climate is merely a surface feature of culture, but a meaningful, measurable, and comparable feature.

# ANTECEDENTS TO SAFETY CLIMATE

The measure of safety climate used in this study (Zohar, 1980) taps into perceptions of what a supervisor expects, rewards, and supports in the context of safety. Thus, it makes sense to study potential antecedents of safety climate that would shape employee's perceptions of supervisor expectations. It also makes sense to examine the variables that could influence how seriously supervisor expectations are taken. For example, supervisor led AARs are a great opportunity to shape safety climate by reinforcing supervisor expectations around safety. Perceptions of supervisor trustworthiness and behavioral integrity give the supervisor (and their expectations) legitimacy. As I argue later in this paper, trustworthy supervisors are more likely to be "repaid". If these trustworthy supervisors are engaging in frequent AARs then they are likely to be "repaid" with a stronger safety climate.

## Retrospective Sensemaking

Safety climate refers to the measurable shared attitudes about safety that are a product of group retrospective sensemaking. Retrospective sensemaking is a dynamic, communicative, and intersubjective process which has been used to explain a variety of phenomena (Weick, 1995). In the high reliability and safety literature retrospective sensemaking is the theoretical framework used to explain how organizational members identify hazardous shifts in their environments and come to a shared understanding of what is more or less dangerous.

Weick, et al. (1999) argue that successful sensemaking is the process that leads to a state of shared group knowledge called collective mindfulness. Organizational members literally make sense of past shared events piecing together their meaning and implications

for future events. It is an ongoing learning process that ultimately improves reliability within these organizations.

Both safety climate and group retrospective sensemaking about safety and danger are constantly renegotiated through communicative means. They are emergent and perishable so they must be continually reaccomplished via interaction. AARs are the venue for this interaction. The safety climate that is measured by a quantitative assessment is the outcome of group sensemaking. Indeed, Allen, et al. (2010) found a positive relationship between AARs and group safety climate. AARs are group meetings after an event used to discuss what happened, what could have been done differently, and how it could have been improved. They are structured opportunities to engage in retrospective sensemaking. AARs are usually conducted on the group level and their ultimate goal is to detect and analyze errors which serve to reduce them in the future (Van Dyck, Frese, Baer, & Sonnentag, 2005). They are opportunities to share stories about learning experiences which in turn improve reliability (Weick, 1987). This is because the shared perception of safety and danger is strengthened and brought up to date with new information. Each "round" of sensemaking (properly executed) acts as a revision on meaning which identifies errors and fixes them. AARs are one way organizational members can engage in retrospective sensemaking.

Considering the previously established relationship between AAR frequency and safety climate (Allen, et al, 2010) it is likely that I will find a similar relationship. Thus, as a form of replication I suggest the following hypothesis.

Hypothesis 1: AAR frequency will be positively related to safety climate.

AARs are frequently used in the military and fire service in which group members discuss events after the fact (Baran & Scott, 2010). Topics of discussion usually involve what went right, what went wrong, and what could be improved for the next time. They are especially effective in the fire service because of the discrete calls that a fire crew engages in. Firefighters get a call, race to the scene of a fire (or medical emergency), then, when they are finished come back to the station. This is a great opportunity to engage in retrospective sensemaking via an AAR.

Perceived Supervisor Trustworthiness

Cox, Jones, & Collinson (2006) argue that trust is integral to safety culture because it creates expectations that managerial commitments to safety are valid. Trust sets up a framework from which all organizational members can work towards common goals (such as safety or reliable operations). Rotter (1967) defines trust as "an expectancy held by an individual or group that the word, promise, verbal, or written statement of another individual can be relied on" (pg. 650). Trust leads to open and honest communication among group members because of the implied congruence between what an individual says and what they do drives honesty (Simons, 1999). As I will argue later in this paper behavioral integrity (the congruence between words and deeds) leads to perceptions of trust which in turn drives honesty and open communication.

Trust is vitally important to leadership, especially in high risk organizations, because honest communication can aid in accurate risk appraisal (Cox, et al, 2006). For example, if a group member feels that they are not adequately trained to do a dangerous task they ought to bring it up to their peers and supervisor. To feel comfortable doing this trust needs to be present. Fear of retribution or punishment may impede that person from

being open and honest. Perceived managerial trustworthiness drives safe behaviors through honest and open communication via an exchange relationship.

Using social exchange theory (Blau, 1964), Cox, et al. (2006) argue that perceptions of managerial trustworthiness in regards to safety will be rewarded by safe behaviors. They conducted two case studies and found that "low levels of trust resulted in a lack of cooperation and communication among employees and managers" (pg. 1136). Hofmann & Morgeson (1999) conducted a similar study and found corroborating results. They found that supportive leaders (as measured by leader-member exchange) in a high risk organization were "repaid" with more open safety communication and safety behaviors. While they used leader-member exchange (instead of perceived supervisor trustworthiness), they still provided evidence in support of social exchange theory as a valid framework to study safety and perceptions of leaders.

Conversely, DePasquale & Geller (1999) found evidence for the role of distrust as a barrier to safe behaviors. They conducted focus groups and interviews and found trust to be a major theme in engaging in a behaviorally based safety program. They also found that a lack of buy-in by front line supervisors, a lack of transparent communication concerning safety from top management, and the use of negative feedback as other obstacles to using a behaviorally based safety program. Further, they found quantitative evidence across 20 organizations that trust in peers and management was related to engaging in a behaviorally based safety program. "Interpersonal trust is what's missing in a culture deemed unready for behavior based safety" (Geller, 1998, pg. 14).

Another example of the importance of trust in high risk organizations is a study conducted by Collinson (1999) who examined an offshore oil rig's safety culture. He

studied the effects of an organizational policy where safe behaviors were linked to compensation and other material rewards via scores on safety performance reviews. This was done by providing bonuses to work groups that went a certain number of shifts without a recorded accident. Unfortunately, this led to underreporting accidents. Employees did not communicate errors because, in short, it was punished.

Employees were not cooperating with management because that could lead to losing a job. Management was asking employees to report accidents while punishing these accidents. Thus, they were unintentionally punishing accident reporting. From the perspective of the oil rig employees, management could not be trusted with accurate accident information. To compensate for this the employees underreported their accident rates. A low level of perceived trust in this case was "repaid" with underreporting of accidents.

Conchie & Donald (2006) corroborated these case study findings with a quantitative study examining trust and distrust in an HRO. They found that trust is related to accident rates and shared attitudes about safety. Much like Hoffman & Morgeson (1999) who argue that subordinates repay a supportive supervisor (as measured by leader-member exchange) by engaging in more open safety communication and safety behaviors, it is reasonable to expect that subordinates repay a trustworthy supervisor by engaging in open and honest retrospective sensemaking in AARs. Cox, et al. (2006) argue that high levels of trust within an organization, specifically in the relationship between a supervisor and their subordinate, can lead to open and honest communication. Kramer (1999) found that high levels of trust were related to group cooperation and information sharing.

Considering the previous section on perceived supervisor trustworthiness and the link that Conchie & Donaldson (2006) and Cox, et al. (2006) make between perceptions of supervisor trustworthiness and safety attitudes, behaviors, and ultimately, safety climate; I propose the following hypothesis.

Hypothesis2: Perceived supervisor trust will be positively related to safety climate.

Hofmann & Morgeson (1999) found a similar relationship between leader supportiveness and more open safety communication (defined as bringing up safety concerns). Considering the evidence supporting perceived leader trustworthiness leading to repayment from subordinates it is likely that leader supportiveness is an artifact of perceived trustworthiness. That is, trustworthy leaders are likely viewed as supportive, but supportive leaders are not necessarily viewed as trustworthy. While the two are related, it is clear that perceived leader trustworthiness is linked to group cooperation, information sharing in a group, safety related attitudes, and safety related behaviors (in the proper high risk context). Leader supportiveness is simply along for the ride.

Retrospective sensemaking is a communicative process that benefits greatly from open communication and group cooperation. Open and honest sensemaking (which ideally occurs in AARs (Scott, Allen, Bonilla, Baran & Murphy, under review), in turn, leads to appropriate shared meaning concerning hazards, which then improves group safety climate. Thus we would expect a positive relationship between perceived supervisor trust and group safety climate. In fact, this relationship would trump the relationship between LMX and safety climate because of the clear links between perceived supervisor trust and group cooperation and shared safety attitudes (Collinson, 1999; Conchie & Donaldson, 2006; Cox, et al., 2006; DePasquale & Geller, 1999). That

is, the link between LMX and group cooperation has not been suggested in previous research (although the relationship between LMX and safety attitudes has been). Further, perceived supervisor trust is a more specific characteristic of a supervisor compared to general supervisor supportiveness. Thus, it ought to have stronger relationship with safety climate. For this reason I propose the following two part hypothesis.

Hypothesis 3a: LMX will be positively related to safety climate.

Hypothesis 3b: Perceived supervisor trust will be positively related to safety climate above and beyond LMX.

Behavioral Integrity

Whitener, Brodt, Kosgaard, & Werner (1998) argue that there are five categories of behaviors that influence trust. These are behavioral consistency, behavioral integrity, sharing of accurate information, delegation of control, and concern for the welfare of subordinates. Kouzes & Posner (1992) argue that subordinates are more likely to trust a supervisor if he or she practices what they preach- that is, if he or she exhibits behavioral integrity.

Behavioral integrity is a subjective perception of an individual or organization and is defined as "the perceived congruence between values expressed by words and those expressed by actions" (Simons, 1999, pg. 90). Carlson & Perrewe (1995) argue trust requires integrity while Simons (1999) suggests that the best way to build integrity is "through actions consistent with espoused values" (pg. 92).

Many definitions of trust include a component of behavioral integrity (Simons, 1999). Mayer, Davis, & Schoorman (1995) found that integrity was a factor of organizational trust in an empirical study. This makes sense when you consider what trust

really is. As mentioned in a previous section, Rotter (1967) defines trust as "an expectancy held by an individual or group that the word, promise, verbal, or written statement of another individual can be relied on" (pg. 650). Consistency is essential. An individual must show a pattern of consistent and reliable behavior to be perceived as trustworthy. A way to be seen as consistent and reliable is to follow through on words with deeds. Thus, behavioral integrity should be a primary antecedent to the perception of trust which in turn will lead to improved safety climate. To test this I propose the following two part hypothesis.

Hypothesis 4a: Behavioral integrity will have a positive relationship to safety climate.

Hypothesis 4b: Supervisor trust will mediate the relationship between behavioral integrity and safety climate.

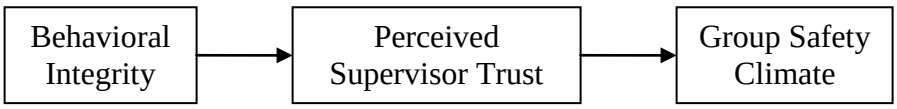


FIGURE 1: Behavioral Integrity and Safety Climate

Simons (2002) places trust immediately after behavioral integrity in a conceptual model of the antecedents and outcomes of the construct. In a study on race, trust, and behavioral integrity, Simons, Friedman, Liu, & Parks (2007) found that perceptions of supervisor behavioral integrity were strongly related to perceptions of supervisor trust.

I have proposed in hypothesis 4b that the perception of supervisor behavioral integrity is an antecedent to perceptions of a trustworthy supervisor. This occurs through the mechanism of a supervisor exhibiting consistent and reliable behaviors (with their espoused safety values) which leads to the expectation that a supervisor's words can be relied upon. This trust, in turn, enhances retrospective sensemaking occurring in AARs.

This is through a reciprocation process where a trustworthy supervisor is “repaid” by subordinates for his or her trustworthiness by engaging in the shared, intersubjective, and cooperative sensemaking process within AARs.

Subordinates repay their supervisor with high quality sensemaking during AARs because perceptions of trust lead to information sharing (Bonacich & Schneider, 1992) and group cooperation (Yamagashi & Cook, 1993) - two important characteristics of the sensemaking process. It can be argued that too much information sharing could also lead to ambiguity and thus not aid in the sensemaking process. However, consider that sensemaking is about constantly sharing to create emergent frameworks about safety and reliability. Information sharing is a necessary component of this. Group cooperation is certainly a necessary component of this as well. The only possible way information sharing and group cooperation could degrade sensemaking is if there is already so much of it that it is a detriment. This does not seem like a rational assumption to make about groups considering it is unclear how much group cooperation is too much and that a certain level of information sharing and group cooperation is absolutely necessary for sensemaking to occur at all.

The relationship between supervisor trustworthiness and sensemaking in AARs will, however, depend on the frequency of opportunities to engage in group sensemaking. AARs are an excellent example of opportunities for sensemaking. They are the context that frames what a supervisor expects, rewards, and supports. If your supervisor held frequent meetings to discuss specific events it would likely send the message to you that your supervisor values something about those events. Further, if you perceived your supervisor as trustworthy (perhaps because they exhibit behavioral integrity) then it

would likely strengthen the message of what your supervisor expects, rewards, and supports. The two would interact to form attitudes in you the subordinate. Thus, I propose that AAR frequency will moderate the relationship between supervisor trustworthiness and retrospective sensemaking, the successful outcome of which is group safety climate.

Hypothesis 5: AAR frequency will moderate the relationship between perceived supervisor trust and group safety climate such that higher levels of AAR frequency will strengthen the relationship between supervisor trust and safety climate.

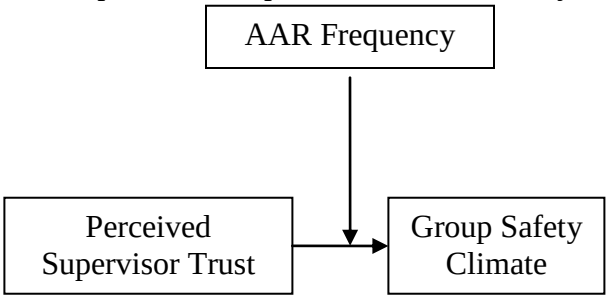


FIGURE 2: AAR Frequency as a Moderator

The outcome of successful retrospective sensemaking (appropriately identifying hazards in the environment) is group safety climate. A strong group safety climate is one in which safety is highly regarded and seen as more important than other organizational demands. Good retrospective sensemaking ought to lead to placing a strong importance on safety.

Further, leader behaviors during an AAR ought to have an relationship to safety climate. That is, leader behaviors during an AAR make for a good (or bad) AAR. This is because AARs are leader-led events. How a leader runs a meeting will affect the outcome of that meeting. The supervisor behaviors used in this study are empirically derived from firefighters who engage in AARs. They are literally subject matter experts on the topic of what makes for a good AAR. It follows that these behaviors ought to have a positive

relationship to safety climate considering AARs are a venue for sensemaking where a supervisor can highlight what they expect, reward, and support.

These supervisor AAR behaviors would likely be mediated by trust perceptions. This is because leader behaviors enhance perceptions of trust, especially when they are in line with espoused values.

Hypothesis 6a: Good AAR leader behaviors will have a positive relationship to safety climate.

Hypothesis 6b: Perceived supervisor trust will mediate the relationship between good leader behaviors and safety climate.

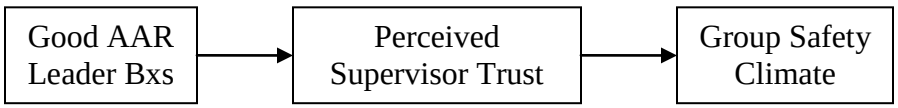


FIGURE 3: Good AAR Leader Behaviors

# METHODS

## Procedure

I conducted a study in which participants were surveyed about their attitudes regarding their group, their supervisor, the frequency of and nature of team meetings, and their perceptions of safety. Considering the shared nature of the constructs and the shared nature of the theories I am using (group retrospective sensemaking, group safety climate, etc.) I aggregated all measures to the group level. Using ordinary least squares regression and exploratory factor analysis I tested my hypotheses. Survey items were administered using an internet based survey that was accessible from work or home.

## Participants

Participants were firefighters in different crews and stations in a large city in the American southeast. Participants were asked to identify their station and crew so they could be appropriately grouped. Because the ultimate dependent variable in this study (group safety climate) is a group level variable, all data was aggregated to the group level, in this case it is the crew level. Crews provide an excellent natural group to study because firefighters work consistently with the same crew members including their supervisor (crew captain). This provides opportunity to engage in retrospective sensemaking-the process that should improve safety climate and reliability.

In total 376 firefighters started the survey but they did not all complete it. 330 cases were left when incomplete data was removed. Out of this number 208 (63%) were crew members while 122 (37%) were crew captains. This study focused on crew member perceptions of their group and their supervisor. To aggregate perceptions to the

appropriate target I removed all captains that completed the survey. All following demographics and analyses focus on the 208 crew members that completed the survey.

The fire service is a male dominated field and this sample reflects that. 197 (94.7%) of the participants that completed the survey are male. The average age of the sample is 38 years and the average organizational tenure is 12.4 years. Both age and tenure were normally distributed.

Measures

All scales on the survey used a 5 point response scale, *Strongly Disagree* to *Strongly Agree.* Table 1 has a list of means, standard deviations, and sample sizes (individual and group) for each scale.

TABLE 1: Means, Standard Deviations, and Aggregation Statistics

| Variable | Individual N | Group N | Mean | SD | Alpha | $R_{wg}$ | ICC(1) | ICC(2) |
|---|---|---|---|---|---|---|---|---|
| AAR Frequency | 208 | 69 | 3.71 | .37 | .70 | 0.80 | 0.25 | 0.61 |
| LMX | 208 | 69 | 3.91 | .57 | .67 | 0.67 | 0.57 | 0.88 |
| Safety Climate | 208 | 69 | 3.70 | .58 | .96 | 0.75 | 0.66 | 0.94 |
| AAR Leader Behaviors | 207 | 69 | 3.87 | .53 | .97 | 0.75 | 0.66 | 0.97 |
| Behavioral Integrity | 206 | 69 | 3.84 | .57 | .97 | 0.68 | 0.82 | 0.97 |
| Perceived Supervisor Trust | 206 | 69 | 4.06 | .53 | .79 | 0.81 | 0.38 | 0.80 |

*Note.* Mean and SD represent group values.

Behavioral Integrity. This construct was measured using a scale of behavioral integrity that can be found in Simons, et al. (2007). The scale is well validated and assesses subordinate perceptions of supervisor integrity. Simons, et al. (2007) found an alpha coefficient of .87 for this scale. In this sample the alpha coefficient was .97 with a mean of 3.84 (SD=.57). Sample items include, there is a match between my manager's words and actions, and, my manager delivers on promises.

Perceived Supervisor Trust. This construct was measured using a portion of the Interpersonal Trust at Work Scale (Cook & Wall, 1980) that assesses trust in a leader. Podsakoff, MacKenzie, Moorman, & Fetter (1990) conducted a confirmatory factor analysis and found strong evidence that the construct is unidimensional and reliable with a Tucker-Lewis goodness-of-fit statistic of .96. In this sample the alpha coefficient was .79 and the mean was 4.06 (SD=.53). Sample items include, I feel quite confident that my leader will always try to treat me fairly, and, I feel a strong loyalty to my leader. The scale has six items.

Group Safety Climate. Safety climate was measured using Zohar & Luria's (2005) scale of group safety climate. This is an extremely popular scale of safety climate and has been studied in various contexts, cultures, and organizational settings. Allen, et al. (2010) found an alpha coefficient of .96 for this scale. In this sample the alpha coefficient was .96 with a mean of 3.7 (SD=.58). Items include, My direct supervisor says a good word to workers who pay special attention to safety, and, my direct supervisor discusses how to improve safety with us all. This scale has 16 items.

AAR Frequency. A seven item scale was used to assess AAR frequency. In this sample it had an alpha coefficient of .70 with a mean of 3.71 (SD=.37). A sample item is we frequently conduct after action reviews after a call.

Leader-Member Exchange. Scandura and Pellegrini (2008) LMX-7 measures the relationship between a supervisor and subordinate. LMX is a frequently used scale and has well established reliability and validity. A sample item is, I usually feel that I know where I stand with my immediate supervisor. In this sample the alpha coefficient was .67 with a mean of 3.91 (SD=.57). The scale has seven items.

AAR LeaderBehaviors. As part of a previous study (Bonilla, unpublished manuscript) firefighters were given an online survey about safety norms, attitudes, and after action reviews. One section asked in an open-ended format to describe what makes for a good and a bad AAR. The question was "In your own words, what makes for a good AAR". Out of 247 possible participants, 163 completed this portion of the survey. Results show that there were no significant differences on responses to this survey item based on tenure, organizational position (captain vs firefighter) age, sex, or race ($p > .05$) using simple t-tests. Roughly 50% of participants who completed this portion of the survey were captains.The scale has 11 items.

Working with other subject-matter experts we categorized the answers in groups of common responses using a constant comparative method (Strauss & Corbin, 1998). I first coded responses using an emic approach where I let the wording of the responses drive the wording of the categories. I then went back and reviewed my coding method to consolidate categories in some instances and split up categories in others. I then created definitions of each coding category and provided it to other subject matter-experts. They reviewed my codes and definitions. Interestingly, respondents referenced the importance of their supervisor in good AARs frequently without being prompted. This suggested that leadership was an important part of AAR effectiveness. Finally, this led to the item creation process.

I created sample items, had another subject matter expert vet and revise them, had another subject-matter expert review them and then made changes based on feedback. This process continued until agreement on items was reached. Eleven categories were

identified for the item asking about what makes a good AAR. See table 2 for the results of the study.

In this study the alpha coefficient was .97 with a mean of 3.87 (SD=.53). The assumption of an alpha coefficient is unidimensionality. For this reason an exploratory factor analysis was conducted to test for dimensionality. Results are discussed in the following section and are displayed in table 3.

TABLE 2: Themes and Definitions of a Good After Action Review

| Good AAR Themes | | | |
|---|---|---|---|
| Theme | Conceptual Definition | Example | Percent |
| Strengths | Any discussion of what went right during a call, praise for appropriate actions (positive reinforcement), or general discussion of behaviors worth repeating. | "Praise where deserved." "Praise those for doing well." "What went right." | 27% |
| Growth Areas | Any discussion of what went wrong during a call, pointing out mistakes, or areas that need training/elaboration. This includes constructive criticism. | "Discuss what we could have done better." "What went wrong." | 43% |
| Group involvement | A discussion that involves all members **of the crew** (and no one else) that were involved. One in which multiple points of view are represented and questions are asked. | "Everyone gets a chance to speak." "Everyone talks, they verbalize concerns." | 20% |
| Respect | Showing respect for **other** members of the crew. This can involve emotional respect, listening to others, or generally showing empathy for other crew members. | "Asking are you ok." "Don’t acuse." | 22% |
| Capt/Moderator | Any mention of a discussion moderator or the importance of someone taking charge of the conversation. | "Clear direction." "Don’t arm chair quarterback." | 9% |

| | | | |
|---|---|---|---|
| Open Comm./Honesty | Engaging in open dialogue with crew members. This includes being honest and clear with crew members and allowing everyone their turn. It also includes having freedom of voice. | "Open discussion." "Be honest and fair." | 40% |
| Task Focused | Discussing the specifics of the call including what everyone actually did during the call. This includes being objective during the discussion and focusing on actions rather than individuals. | "Objectivity." "Discuss why we did what we did." | 24% |
| Relaxed/Open | Creating an atmosphere that allows for easy communication among crew members. This includes being informal, being relaxed, and having a generally positive attitude about the process. | "Try to create a positive atmosphere for discussion." "Decompress and lower stress." | 14% |
| Prompt | Making sure that the AAR starts on time and does not run long. | "Do it as soon as possible." "Immediate feedback." | 5% |
| Learning | Any specific mention of learning, education, or a learning opportunity. | "We mention what went extremely well to assure others will know and learn from it. We point out the small things we experienced to assure information available to all." | 13% |
| Humor | Any mention of jokes, laughing, or comedy. | "Good jokes. Pointing out funny things that happened." "Find some humor." | 2% |

Exploratory Factor Analysis

An exploratory factor analysis was conducted to assess the unidimensionality of the supervisor AAR behavior scale. A principal axis factor analysis was conducted and

factors were allowed to rotate. One factor was extracted and accounted for 68.5% of the variance in the sum of square loadings. The eigenvalue was 12.6 for the first factor. The second factor had an eigenvalue of .84. If an eigenvalue falls below 1.0 it suggests that the factor accounts for less variance than any given item and does not reduce the scale into a subset of factors. For these reasons a 1 factor solution is the most appropriate interpretation of these data. See table 3 for a list of items and factor loadings. All items start with the stem *During AARs our captain…*

TABLE 3: Factor Loadings for Supervisor AAR Behaviors

| Supervisor AAR Behavior Scales | Factor Loadings |
|---|---|
| Gives praise where it is deserved. | .87 |
| Praises us for the good things we did during the call. | .88 |
| Praises us for what went right during the call. | .88 |
| Discusses what we could have done better during the call. | .81 |
| Talks about what went wrong during the call. | .65 |
| Allows everyone a chance to speak. | .81 |
| Encourages us to speak up about the call. | .86 |
| Asks how we felt about the call. | .87 |
| Respects the concerns of crew members. | .88 |
| Provides clear direction for the meeting. | .88 |
| Encourages us to voice our concerns. | .90 |
| Encourages us to listen to the speaker. | .86 |
| Discusses everyone's role during the call. | .90 |
| Discusses actions, not people, that were right or wrong. | .81 |
| Starts the meeting promptly after the call. | .70 |
| Points out small things crew members experienced so that others can learn. | .85 |
| Talks about what can be learned from the call. | .84 |
| Points out funny things that happened during the call. | .53 |

*Note*. N=239.

An examination of these factor loadings suggests that the humor item loads poorest onto the scale. Considering the themes of the other items (serious discussions, good meeting practices, learning) this makes sense. Interestingly, the item *discusses what went wrong during the call* loads poorly as well. However, the item directly above it,

*discusses what we could have done better during the call*, loads very well. This suggests an issue of wording rather than meaning. Perhaps the negative wording (use of the word "wrong") caused it to load differently than the more positive wording of the previous item (use of the word "better").

Aggregation of Variables

The theoretical backing for this study is group level phenomenon. For this reason the focal variables were aggregated to the group level. In this case the group is a firefighting crew. In the fire service crew members work almost exclusively together (barring covering a coworker's shift) and thus have opportunity to create group norms and a group climate.

There are very specific steps for aggregation outlined by LeBreton & Senter (2008) and earlier by Bliese (2000). First, the dataset must meet three criteria. The unit of analysis must occur naturally, there must be within group homogeneity, and there must be between group heterogeneity. The dataset meets all three criteria. As described earlier, firefighters work in crews as their primary work group. They direct up to a consistent captain who acts as their supervisor. Crews vary in size; in this sample the average crew had around 3 members with a minimum of 2 and a maximum of 7.

The second and third criteria are met using three statistics. All aggregation values can be found in table 1. The first statistical value is $r_{wg(j)}$ which is a measure of within group agreement. To calculate this I first restructured the dataset as described by LeBreton & Senter (2008). I then ran a calculation that compares the observed variance in group member ratings of a target (safety climate for example) to the expected variance if their responses were completely random.

Picture a histogram of responses for each group. The response options are made up of the 5 point scale I provided on the survey. If the group members had perfect agreement then the histogram would have all the responses bucketed into one response option (let us say option 4 in the example). If they had perfect *disagreement* then their response options would be spread evenly across the 5 points scale and would create a rectangular shaped histogram. The $r_{wg(j)}$ statistics compares the actual response histogram to a rectangular histogram. The more different they are, the higher the $r_{wg(j)}$, and the more confidence we have that there is within group homogeneity. An $r_{wg(j)}$ is calculated for each group. These values are then averaged for each variable in question.

Technically, one can get negative values for this statistic, but that is usually a sign that the dataset has not been properly organized. So, in practice the statistic ranges from 0 to 1.0 with .70 as a rule of thumb cut-off for agreement (Bliese, 2000). For this study the $r_{wg(j)}$ values exceeded the .70 cut off for AAR frequency (.80), safety climate (.75), supervisor AAR behaviors (.75), and perceived supervisor trust (.81). The values fell just short of the .70 cutoff for LMX (.67) and for behavioral integrity (.68). This suggests that there is slightly more within group variance than would be ideal for LMX and behavioral integrity.

However, there is another statistic that can be used to assess within group homogeneity- ICC(1). This statistic can be interpreted as the proportion of variance attributed to group membership. Consider that simply being in a group can have a relationship to individual attitudes. Indeed, that is exactly what I argue in this paper. This effect can then be split into (explained by) different aspects of the group. For example, a group's supervisor may enact certain behaviors that elicit certain attitudes from all group

members. ICC(1) tells us how much variance can be explained by group level phenomenon. The ICC(1) values are high for the variables in question. AAR frequency was .25, LMX was .57, safety climate was .66, AAR leader behavior was .66, behavioral integrity was .82, and perceived supervisor trust was .38. These suggest good within group homogeneity.

The final criterion for aggregation is between group heterogeneity. ICC(2) is a statistic that tells us if the group means for each variable are reliably different. If the group means are too close to each other (and unreliable) then we cannot be sure their differences are due to group level phenomenon (unless there is much more statistical power). In this case we want there to be a lot of variance across groups (which means a lot of variance to account for with our variables). ICC(2) tells us if the group means are different enough to derive meaningful relationships. Bliese (2000) suggests a cutoff of .70 for this statistic. Only AAR frequency fell below this mark with an ICC(2) value of .61. LMX was .88, safety climate was .94, AAR leader behavior was .97, behavioral integrity was .97, and perceived supervisor trust was .80.

Considering the amount of variance accounted for by group level phenomena as illustrated in table 1, the use of hierarchical linear modeling (HLM) does not seem appropriate. HLM is used primarily when the researcher is interested in examining both level 1 (in this case individual level) and level 2 (group level) sources of variance. In this study the high ICC(2) values suggest that there is very little variance attributable to individual sources in the variables measured. Thus, there would be no significant individual level sources of variance. Consider also that there is no theoretical reason to

run multilevel modeling either. That is, the phenomena studied ought to occur on the group level.

This provides further reason to aggregate to the group level. It appears that the main sources of variance operate on that level. While there are examples in this dataset where variables fall below the cutoff value there is not one variable which consistently fails to meet all of the criteria for aggregation. Taken as a whole I believe the dataset is appropriate for aggregation. Moving forward all analyses will occur on the group level (N=69).

# RESULTS

Analyses will be organized by hypothesis for simplicity. On both the individual and group level, age, organizational tenure, and group size did not have a significant relationship with the study variables. For that reason I have not included them in any analyses as control variables. Hypothesis 1 (AAR frequency will be positively related to safety climate) was supported by the data. See table 4 for correlations. AAR frequency was positively related to safety climate (r=.28, $p<.05$). This finding was important for two major reasons. The first is that it supports the assertion that AARs have a positive impact on safety climate. The second is that it sets the stage for the rest of the hypotheses. All other hypotheses assume that AARs act as opportunities for sensemaking which in turn ought to positively impact safety climate. An in depth discussion of the theoretical impact of these (and all other) findings of this study will be presented in the discussion section below.

Hypothesis 2 (perceived supervisor trust will be positively related to safety climate) was also supported by the data. Perceived supervisor trust was positively related to safety climate (r=.67, $p<.001$). See table 4 for correlations. The strong statistical relationship is promising because perceptions of supervisor trust ought to be repaid in high risk contexts with a strong safety climate (Hoffman & Morgeson, 1999). This hypothesis along with the hypothesis 3a and 3b all support the idea that trust and safety climate can act as an exchange relationship as first proposed by Blau (1964).

Hypothesis 3a (LMX will be positively related to safety climate) was supported by the data. LMX was positively related to safety climate (r=.67, $p<.001$). See table 4 for correlations. This finding is essentially a replication of the work done by Hoffman and

others (1998; 1999). The current theory argues that in high risk contexts an exchange relationship exists between supervisors and their direct reports. If supervisors provide a high quality relationship to their direct reports then they will "repay" their supervisor with behaviors they assume their supervisor values. In high risk contexts these would be safety behaviors and the formation of strong safety attitudes. This, in turn is reflected in a positive relationship between LMX and safety climate.

TABLE 4: Correlations among Study Variables

| | Variables | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1 | AAR Frequency | (.80) | | | | | |
| 2 | Perceived Supervisor Trust | 0.24 | (.75) | | | | |
| 3 | LMX | 0.19 | 0.77 | (.67) | | | |
| 4 | Behavioral Integrity | 0.18 | 0.81 | 0.74 | (.68) | | |
| 5 | AAR Leader Behaviors | 0.34 | 0.68 | 0.76 | 0.63 | (.75) | |
| 6 | Safety Climate | 0.28 | 0.67 | 0.67 | 0.73 | 0.71 | (.75) |

*Note.* N=69. Values in parentheses are Rwg. Values greater than .27 are significant at p<.05. Values greater than .32 are significant at p<.001.

Hypothesis 3b (perceived supervisor trust will be positively related to safety climate above and beyond LMX) was also supported by the data. Testing this hypothesis involved a two-step regression analysis. See table 5 for beta weights, significance testing, and variance explained. The first step was to show the relationship between LMX and safety climate. The unstandardized beta weight in step 1 was .68 ($p<.05$). In the second step I included perceived supervisor trust as an additional independent variable. I was looking for two things. The first is a significant positive relationship between perceived supervisor trust and safety climate *after accounting for the effect of LMX*. This would mean perceived supervisor trust has a unique relationship to safety climate apart from

LMX. Further, I was looking for a reduction in the relationship between LMX and safety climate when accounting for the effect of perceived supervisor trust. This would suggest that perceived supervisor trust has an relationship to safety climate above and beyond that of LMX.

In support of hypothesis 3b both of these criteria were met. The unstandardized beta weight for the relationship between perceived supervisor trust and safety climate was .42 ($p<.05$). The unstandardized beta weight for the relationship between LMX and safety climate drops from .68 ($p<.05$) in step 1 to .38 ($p>.05$) in step 2. Implications of these findings will be covered in the discussion section.

TABLE 5: Two-Step Regression with Safety Climate as the Dependent Variable

| | | *b* | B | S.E. | R2 |
|---|---|---|---|---|---|
| Step 1 | Intercept | 1.04 | | 0.37 | 0.45 |
| | LMX | 0.68 | 0.67 | 0.09 | |
| Step 2 | Intercept | 0.52 | | 0.39 | 0.50 |
| | LMX | 0.38 | 0.37 | 0.14 | |
| | Perceived Supervisor Trust | 0.42 | 0.38 | 0.15 | |

*Note.* All values significant at p<.05.

Hypothesis 4a (behavioral integrity will have a positive relationship to safety climate) was supported by the data. Behavioral integrity was positively related to safety climate (r=.73, $p<.001$). See table 4 for correlations. This relationship helps set up hypothesis 4b.

Hypothesis 4b (supervisor trust will mediate the relationship between behavioral integrity and safety climate) was not supported. Steps to test for mediation provided by Baron & Kenny (1986) were used. The first step is to test the relationship between the independent variable and the mediator. In this case that is behavioral integrity and supervisor trust. The first half of table 6 contains all relevant statistics for this analysis.

Behavioral integrity is significantly related to supervisor trust (*b*=.75, *p<.001*). This satisfies the first step of mediation.

The next step is to test the relationship between behavioral integrity and safety climate (the independent variable and the dependent variable). Step 1 in the lower portion of table 6 contains this analysis. Behavioral integrity is significantly related to safety climate (*b*=.74, *p<.001*). This satisfies the second step of mediation.

The final step for mediation is to rerun the previous step and include the mediator. If it is a significant mediation then the independent variable will fall to non-significance because the mediator is accounting for all of the shared variance originally accounted for by the independent variable. This criterion was not met. Supervisor trust fails to reach significance when accounting for the relationship between behavioral integrity (*b*=.25, *p>.05*). Further, behavioral integrity (*b*=.55, *p*<.001) remains significant even with the inclusion of supervisor trust.

The unstandardized beta weight for behavioral integrity does drop somewhat suggesting that partial mediation may be occurring. However, the Sobel test was not significant (1.63, *p=.102*).

TABLE 6: Test of Mediation of Supervisor Trust on Behavioral Integrity and Safety Climate

| DV: Supervisor Trust | | *b* | S.E. | B | R2 | ΔR2 |
|---|---|---|---|---|---|---|
| | Intercept | 1.17 | 0.26 | | 0.66 | 0.00 |
| | Behavioral Integrity | 0.75 | 0.07 | 0.81 | | |
| DV: Safety Climate | | *b* | S.E. | | R2 | ΔR2 |
| Step 1 | Intercept | 0.87 | 0.33 | | 0.53 | 0.00 |
| | Behavioral Integrity | 0.74 | 0.08 | 0.73 | | |
| Step 2 | Intercept | 0.58 | 0.37 | | 0.54 | 0.02 |
| | Behavioral Integrity | 0.55 | 0.14 | 0.54 | | |
| | Supervisor Trust | 0.25 | 0.15 | 0.23 | | |

*Note.* N=69 groups. * denotes p<.001.

Hypothesis 5 (AAR frequency will moderate the relationship between perceived supervisor trust and safety climate such that higher levels of AAR frequency will strengthen the relationship between supervisor trust and safety climate) was not supported by the dataset. Table 7 contains all the relevant statistics for this analysis. Baron & Kenny (1986) provide steps to test for moderation that were followed for this analysis. The first step is to center the independent variable and the moderator to ease interpretation. Then, the independent variable and the moderator are included in a regression on the dependent variable. In this case the independent variable, supervisor trust (*b*=.70, *p<.001*), and the moderator, AAR frequency (*b*=.20, *p>.05*), were included.

The next step is to calculate the interaction term. This is done by multiplying the independent variable and the moderator. This interaction term is then included in the previous regression to see if it accounts for variance in the dependent variable above and beyond that of the linear variables. If it does then it means that a non-linear variable accounts for variance in the dependent variable and the relationship between X and Y is dependent on the level of the moderator. The interaction term was not significant (*b*=-.01, *p>.05*) and thus, hypothesis 5 was not supported by this dataset.

TABLE 7: Test for Moderation with Safety Climate as the Dependent Variable
Test for moderation of AAR Frequency on Supervisor Trust and Safety Climate

| DV: Safety Climate | | b | S.E. | B | R2 | ΔR2 |
|---|---|---|---|---|---|---|
| | Intercept | 3.70 | 0.05 | | 0.47 | 0.00 |
| Step 1 | Supervisor Trust (Centered) | 0.70 | 0.10 | 0.64 | | |
| | AAR Frequency (Centered) | 0.20 | 0.14 | 0.13 | | |
| | Intercept | 3.70 | 0.05 | | 0.47 | 0.00 |
| Step 2 | Supervisor Trust (Centered) | 0.70 | 0.10 | 0.64 | | |
| | AAR Frequency (Centered) | 0.20 | 0.15 | 0.13 | | |
| | Interaction Term | -0.01 | 0.31 | 0.00 | | |

*Note.* N=69 groups. * denotes p<.001.

Hypothesis 6a (supervisor AAR behaviors will have a positive relationship to safety climate) was supported by the dataset. This hypothesis was tested with a simple correlation. Table 4 contains the correlation between these two variables. Supervisor AAR behavior was significantly related to safety climate (r=.71, $p<.001$). This sets up the mediating relationship tested in hypothesis 6b.

Hypothesis 6b (perceived supervisor trust will mediate the relationship between good leader behaviors and safety climate) was partially supported by the data. To test for mediation the same steps used in hypothesis 4b and outlined by Baron & Kenny (1986) were used. These are to first test the relationship between the independent variable and the moderator (supervisor AAR behavior and supervisor trust). The second step is to test the relationship between the independent variable (supervisor AAR behavior) and the dependent variable (safety climate). Finally, the third step is to test the relationship between the mediator (supervisor trust) and the dependent variable above and beyond that of the independent variable.

Table 8 contains all relevant statistics for this analysis. Supervisor AAR behavior was significantly related to supervisor trust ($b$=.68, $p<.001$) meeting the first criteria for mediation. Supervisor AAR behavior was also significantly related to safety climate ($b$=.78, $p<.001$) meeting the second criteria for mediation. Finally, supervisor trust was significantly related to safety climate ($b$=.37, $p<.05$) while accounting for the relationship between supervisor AAR behavior and safety climate. Further, the unstandardized beta weight for supervisor AAR behavior drops from .78 to .53 when supervisor trust is included. This implies that mediation may be occurring. However, the beta does not drop to non-significance, suggesting a partial mediation.

A Sobel test was conducted to measure the indirect effect. The Sobel test value was 2.90 ($p<.05$) which supports partial mediation. Thus, hypothesis 6b is partially supported. Supervisor trust partially mediates the relationship between supervisor AAR behavior and safety climate.

TABLE 8: Test for Mediation with Safety Climate as the Dependent Variable

| DV: Supervisor Trust | | *b* | S.E. | $R^2$ | $\Delta R^2$ |
|---|---|---|---|---|---|
| | Intercept | 1.43 | 0.35 | 0.46 | 0.00 |
| | Supervisor AAR Behavior | 0.68 | 0.09 | | |
| DV: Safety Climate | | *b* | S.E. | $R^2$ | $\Delta R^2$ |
| Step 1 | Intercept | 0.69 | 0.36 | 0.51 | 0.00 |
| | Supervisor AAR Behavior | 0.78 | 0.09 | | |
| Step 2 | Intercept | 0.15 | 0.38 | 0.57 | 0.06 |
| | Supervisor AAR Behavior | 0.53 | 0.12 | | |
| | Supervisor Trust | 0.37 | 0.12 | | |

*Note*. N=69 groups. * denotes p<.05. ** denotes p<.001.

# DISCUSSION

This dissertation focused on after action reviews, leadership behaviors, group attitudes and-importantly- antecedents of safety climate on the group level. Broadly speaking this paper is important because safety climate has a strong, measurable, and immediate relationship to very real accident rates in high risk organizations (Hofmann & Stetzer, 1998; Zohar & Luria, 2005; Zohar, 2008). By gaining a better understanding of the antecedents of safety climate they can more easily be manipulated and, ultimately, accidents at work can be reduced.

In this dissertation I attempted to unravel the leader behaviors that elicit group member attitudes that in turn shape attitudes about the importance of safety within the group. Gherardi, et al. (1998) argue that culture (and by extension, climate) operates on the group level most strongly. It is one's immediate peers and supervisor that truly shape this portion of organizational life through communicative means. Because the very meaning of safety and risk are being formed at this level (Simpson, 1996) safety climate is understandably difficult to shape and manipulate (Choudhry, et al., 2007). Thus, an understanding of the levers that affect safety climate truly solves a difficult and pressing organizational issue.

In regards to theory, this paper attempted to add clarity to the nomological net surrounding safety climate. Zohar (2008) called for research on behavioral integrity and its relationship to safety climate. This paper began to answer that call. Further, this paper identified the nuanced relationship between LMX, perceived supervisor trust, and safety climate. I provided evidence for the idea that perceptions of leader supportiveness (LMX) are subsumed by perceptions of leader trust when attempting to manipulate safety

climate. This confirms the work by Conchie & Donaldson (2006) and Cox, et al. (2006) on the importance of trust in safety perceptions.

I collected data from firefighters to provide support for my hypotheses because they work in natural groups and are truly members of a high risk organization in which safety and reliability are of the utmost importance. Using previously collected qualitative data I was able to derive a behavioral checklist of supervisor behaviors during AARs that now has empirical evidence linking them to safety climate. These are expert-derived best practices that can be shared with others to improve AAR effectiveness and safety attitudes.

Attempting to measure safety and risk in the context of one's coworkers and supervisor was difficult because of the political nature of these topics in the fire service. Safety is seen as a luxury reserved for other jobs. Firefighting is inherently dangerous and many firefighters see that as a source of pride (Scott & Trethewey, 2008). Further, firefighters work in such tightly knit groups that agreeing to negative statements about other group members may have been seen as socially undesirable. For that reason one limitation of this study is the positive bias seen in the mean and standard deviations of the scales measured. If a scale was positively worded then scores tended to be significantly higher than the mid point of the scale.

The rest of this discussion section will be organized by hypothesis to aid understanding. Following that a section will discuss overall findings, limitations, and future directions for research.

AAR Frequency and Safety Climate

The first hypothesis was a replication of Allen, et al. (2010) who found a positive relationship between AAR frequency and safety climate. I was able to replicate these findings, but with a surprisingly lower correlation. In this study the correlation was .28 ($p<.05$) while the Allen, et al. (2010) study found a correlation of .38 ($p<.01$). Considering that theory suggests that AARs are a venue for sensemaking (Hofmann &Stetzer, 1998), it seems that holding more frequent AARs ought to have a stronger relationship to safety climate.

One explanation for the surprisingly weak relationship is the role of group busyness. Allen, et al. (2010) found it to be a significant moderator of the relationship between AAR frequency and safety climate. The less busy groups had a stronger relationship between the focal variables. They accounted for an additional 6% of variance in safety climate by considering this interaction.

While busyness is no doubt an issue to be considered, I believe the somewhat weak relationship of AAR frequency to safety climate points to a more fundamental issue. AAR quality is much more important that AAR quantity. Frequency is a necessary but not sufficient antecedent of safety climate. Holding zero AARs will obviously have a negative relationship to safety climate. However, note that out of all the variables measured in this study AAR frequency had the weakest relationship to safety climate. The rest of the variables, especially supervisor AAR behavior, act as a proxy for AAR quality. Behavioral integrity and supervisor AAR behavior (r=.73 and r=.71) have especially strong relationships to safety climate. Both speak to the leader-specific influence that AAR quality can have on safety climate. Taken together, they imply that captains who maintain good meeting practices (supervisor AAR behaviors) and hold

themselves accountable to those meeting practices (behavioral integrity) will have crews with exceptionally strong safety climates. Holding these high quality AARs frequently would likely create a strong positive interaction relationship to safety climate.

Perceived Supervisor Trust and Safety Climate

The second hypothesis proposed was that perceived supervisor trust would have a positive relationship to safety climate. This hypothesis was supported (r=.67, $p<.001$). Cox, et al. (2006) argue that a trusted supervisor in a high risk organization will be "repaid" with safe attitudes and behaviors. The researchers were using social exchange theory (Blau, 1964) as the framework for this relationship and found qualitative evidence to support it. The current study provides quantitative evidence.

More specifically, a supervisor perceived as being trustworthy will elicit more honest and open communication among their direct reports. This open communication is vitally important because safety, risk, and reliability are ongoing and communicative processes (Weick, et al. 1999) negotiated and renegotiated (Simpson, 1996; Scott & Threthewey, 2008) over time. A supervisor must foster and maintain an environment in which these communicative processes can occur. A supervisor can do this by reviewing the behaviors in the AAR leadership behavior scale and engaging in them while leading an AAR. For example, allowing everyone to speak, respecting the opinions of others, and discussing everyone's role in the event.

There are a variety of explanations for the mechanism at work in this hypothesis. Scott, Allen, Bonilla, Baran, & Murphy (in press) argue that freedom of dissent is an important ingredient in successful sensemaking during AARs. Using theory provided by Kassing (1997) the researchers argue that having the impression that one is free to dissent

(not necessarily dissenting, just feeling free to do so) leads to a variety of positive outcomes for sensemaking. Feeling free to dissent will reduce the likelihood that group members will censor themselves. In a process like sensemaking where decision making ought to migrate towards expertise (Weick & Sutcliffe, 2007) being comfortable dissenting (and not censoring oneself) could lead to ambiguity reduction and ultimately a stronger safety climate. Openness, honesty, and group interaction during AARs (a product of perceived supervisor trust) may lead to perceived freedom of dissent which in turn reduces ambiguity and improves safety climate.

This hypothesis is interesting because it uses Blau's (1964) theory of social exchange as the mechanism that gets it started. Hofmann, et al. (1999) and Zohar & Luria (2005) theorize that in complex organizations supervisors must highlight the most important policies, procedures, and environmental cues. Simply put, supervisors must help direct reports make sense of the organization. In a high risk organization reliability and safety ought to be at the top of the supervisor's list of important issues to highlight. Social exchange theory suggests that direct reports should repay their supervisor with what they expect, reward, and support. If these supervisors are highlighting safety then that is what will be perceived as what they expect, reward, and support in their direct reports.

How a direct report repays their supervisor is an interesting question as well. There must be some sort of contextualizing variable that gives the direct report some guidance on this. In this case the answer is frequent AARs. These act as the venue for repayment. They also act as the venue where supervisors help direct reports make sense

of the organization by highlighting important aspects of the environment. This highlighting is done by enacting the supervisor AAR behaviors measured in this study.

A supervisor who highlights the importance of safety via AARs and is perceived as trustworthy ought to drive safety climate. Indeed, this is exactly what Williams and Geller (2001) argue in their paper on behaviorally based safety and safety culture. Perceptions of trust in one's immediate manager affecting safety climate now has qualitative and quantitative evidence supporting it.

Perceived Supervisor Trust, LMX, and Safety Climate

Hofmann, et al. (1999) first argued that LMX would drive the exchange relationship being "repaid" with safe attitudes and, ultimately, safe behaviors. However, I proposed that it is perceived supervisor trust that truly drives this relationship and that supervisor supportiveness (LMX) is essentially a byproduct of this relationship. That is, a trustworthy supervisor will almost always be perceived as supportive, but a supportive supervisor may not always be seen as trustworthy. Hypothesis 3a and 3b posit that while LMX will surely have a strong relationship to safety climate, perceived supervisor trust will have a relationship above and beyond that of LMX. This is because of the important role trust plays in high risk organizations and their safety culture.

As discussed previously, group members must feel that they can be honest and open with their discussion of hazards, risk, and safety. While a supportive supervisor will have likely have an relationship to these attitudes, a trustworthy supervisor will have a stronger relationship. As predicted, LMX had a strong positive relationship to safety climate ($b$=.68, $p<.001$). However, when considering the relationship of perceived supervisor trust the unstandardized beta weight for LMX drops to .38 ($p<.05$). Further,

when accounting for the relationship of LMX and safety climate the beta weight for perceived supervisor trust (*b*=.42, *p*<.001) is strong, positive, significant, and greater than the unique effect of LMX on safety climate. The data provide empirical evidence supporting a stronger unique effect of perceived supervisor trust on safety climate than LMX on safety climate.

This does not discredit the findings of Hofmann et al. (1999). Instead it highlights the specific nature of the exchange relationship between supervisor and direct report in a high risk setting. Supervisor supportiveness (LMX) is important, but supervisor trustworthiness is even more so. LMX measures the broader and more general attitude of perceived supervisor supportiveness while perceived supervisor trustworthiness is the more specific attitudinal target. Because of the critical role of trust in safety climate it will have a stronger relationship to safety climate.

An alternative explanation is mediation. I tested the relationships in hypothesis 3b but as a mediational model where supervisor trust mediates the relationship between LMX and safety climate. The criteria for partial mediation were met and the Sobel test was significant (p<.05). Thus, it could be possible that LMX informs supervisor trust which in turn has an effect on safety climate. Obviously statements about causation cannot be made, however, it suggests avenues for future research. Perhaps perceptions of supervisor trustworthiness are a product of supervisor supportiveness as measured by LMX.

Behavioral Integrity and Safety Climate

Hypothesis 4a is that behavioral integrity and safety climate will have a positive relationship. This hypothesis was strongly supported (r=.73, *p*<*.001*) and for good

reason. Kouzes & Posner (1992) argue that direct reports are more likely to trust a supervisor if they practice what they preach. Considering the previously established relationship between perceived supervisor trust and safety climate it follows that behavioral integrity ought to have a positive relationship to safety climate.

Behavioral integrity is an interesting construct in relation to safety climate because both focus on consistency. In safety climate we talk about consistency in the form of reliability. Behavioral integrity is defined as the perception of the congruence between words and deeds (Simons, 1999). For supervisors it is about the consistent application of policies and procedures.

Zohar (2008) recommends behavioral integrity as a focus of safety climate research moving forward. He argues that this construct builds trust over time which in turn drives safety climate. To test this relationship I proposed hypothesis 4b which posits a mediating relationship between perceived supervisor trust and the relationship between behavioral integrity and safety climate. In this case behavioral integrity would lead to perceptions of supervisor trust (as proposed by Simons, 1999 among others) which in turn would lead to safety climate (as suggested by Zohar, 2008).

Surprisingly, this hypothesis was not supported. In the first step behavioral integrity had an unstandardized beta weight of .74 ($p<.001$) when accounting for variance in safety climate. In the second step when accounting for the relationship of perceived supervisor trust the unstandardized beta weight for behavioral integrity drops to .55 ($p<.001$). The criterion for full mediation is for this statistic to drop to non-significance which it fails to do. It is possible, however, for partial mediation to have occurred. So, a

Sobel test was conducted to test the significance of the indirect effect. The Sobel test was also not significant meaning that even partial mediation is not supported.

Considering the strong theoretical background for this hypothesis the findings are counterintuitive. There is strong theory and some empirical evidence for the relationship between behavioral integrity and perceptions of trust (Mayer, et al, 1995; Simons, 1999; Simons, et al, 2007). There is also strong theory supporting the relationship between perceptions of trust and safety climate (Collinson, 1999; Cox, et al, 2006) and quantitative (Conchie & Donaldson, 2006) and qualitative (Geller, 1998; DesPasquale & Geller, 1999) evidence in support of this relationship. Taking this into account it is possible that this could be a methodological or statistical power issue. These relationships were drawn from a sample of 69 cases. This is a relatively small number for social science research and for a test of mediation.

For exploratory purposes and to understand if this is potentially a power issue I reran the same mediation analysis on the individual level with non-captain firefighters. this left me with 206 valid cases. The similar pattern of results was found. The independent variable had a positive relationship to the mediator ($b$=.61, $p<.001$). When setting safety climate as the dependent variable the unstandardized beta weight for behavioral integrity dropped from .61 to .45 ($p<.001$ in both cases) when taking the effect of perceived supervisor trust into account. This rules out full mediation on the individual level but still leaves room for partial mediation. A Sobel test was conducted and found to be significant (Sobel value=2.86, $p<.01$) which supports partial mediation.

Importantly, this does not mean the original hypothesis is supported. Rather, it provides an avenue for future research and an explanation for why the original hypothesis

was not supported. If it is an issue of power (which this analysis suggests) then collecting more data ought to be satisfactory. Further, consider that we know these variables aggregate to the group level due to their $r_{wg}$ values and ICC(1) and ICC(2) values. With this in mind, the individual values and statistical coefficients ought to mirror those on the group level. The only real difference should be statistical power.

Perceived Supervisor Trust, AAR Frequency, and Safety Climate

Hypothesis 5 was that AAR Frequency would have a moderating relationship to the relationship between perceived supervisor trust and safety climate. This hypothesis reaches again to social exchange theory (Blau, 1964) first used in hypothesis 3a and 3b. As described above I theorized that perceptions of supervisor trustworthiness would elicit an exchange relationship such that direct reports would "repay" their supervisor with safe attitudes and behaviors. Hofmann & Morgeson (1999) found support for this idea using leader supportiveness as the initiator of the exchange relationship. They argue that the context in which the relationship occurs drives the type of repayment. In high risk contexts the repayment would be safety related because that is the external context being highlighted by management (Zohar & Luria, 2005).

Collinson (1999), Cox, et al, (2006), and Conchie & Donaldson (2006) all found support for the idea that supervisor trust (as opposed to leader supportiveness) could elicit this same exchange relationship in high risk contexts. In this study I found support for this relationship as well and even found that perceptions of supervisor trust accounts for variance in safety climate above and beyond that of leader supportiveness (LMX).

For hypothesis 5 I argued that AARs help to create a context in high risk organizations that safety is valued. The more frequently AARs are held the stronger the

relationship between perceived supervisor trust and safety climate. The AARs act as clues to the way a supervisor wants to be repaid for their trustworthiness. This hypothesis, however, was not supported. The interaction term failed to account for any more variance in safety climate above and beyond the main relationships of perceived supervisor trust and AAR frequency.

This could be due to a variety of issues. However, I believe it is due to the quality over quantity issue highlighted in the discussion of hypothesis 1 (AAR frequency being positively related to safety climate). Consider that the relationship between AAR frequency and safety climate was the weakest of the measured variables (r=.28, $p<.05$). I suggested that this was because the quality of an AAR has a stronger relationship to safety climate than how frequently AARs are held. To support this idea I pointed out that supervisor AAR behavior had a much stronger relationship to safety climate (r=.71, p<*.001*) than AAR frequency. Supervisor AAR behavior could act as a proxy to AAR quality (at least from the point of view of good meeting practices). Remember that this scale was qualitatively derived from firefighters who were asked what makes for a good AAR. It is an expert-derived checklist of AAR best practices in the fire service.

An alternative explanation is that an especially high level of trust is not necessary for safety climate to form. Rather, it is more important that there is simply a lack of distrust. That is, once a minimum level of trust has been reached more does not significantly improve outcomes. Firefighters form tightly knit crews early on and it is likely that this minimum level of trust is earned early in the formation of the group. Once it is set there is little question of trustworthiness amongst group members. There is potential for this to work similar to Herzberg's (1959) hygiene-motivation theory. That is,

a lack of trust among group members will have a negative effect on important outcomes. However, a high level of trust does not necessarily drive outcomes.

Future research ought to look into the formation of crews over time and perceptions of trust. It is possible that early on in the group's history trust plays a much more important role in safety climate. Over time that effect ought to weaken as group members prove that they are trustworthy.

Moving forward, research on the exchange relationship between perceptions of supervisor trust and safety climate ought to focus on how the importance of safety is being communicated to direct reports. The medium and content used by management to impress a safety message should act as a moderator on the trust to safety climate exchange relationship. Obviously, better messaging ought to lead to a stronger relationship. But what does "better" look like?

According to the findings of this study, "better" appears to be a function good meeting practices. Starting on time, allowing others to speak, respecting opinions, and staying on topic are all good meeting practices. They are also AAR leader behaviors that are related to safety climate in a positive way. This is because they help enact the sensemaking process during AARs.

Future research ought to think of sensemaking as meetings. Then the literature on meeting effectiveness could be tied in and used to find best practices for enacting and enhancing the sensemaking process. While sensemaking itself is difficult to measure, the outcomes of good sensemaking are easily measured. Safety climate is an outcome in a high risk environment. However, other more general outcomes could include learning, ambiguity reduction, or even improvement in group agreement. It may be more

interesting to focus on specific outcomes, though. Again, in the fire service that could be safety climate, but in the military it could easily be team effectiveness on a standardized training course. Any time AARs can affect a team in some way then that ought to point to sensemaking.

Supervisor AAR Behavior and Safety Climate

The most forward looking hypotheses in this study focused on behaviors supervisors engage in during AARs that have a positive relationship to safety climate. Hypothesis 6a was that supervisor AAR behavior would have a positive relationship to safety climate. This hypothesis was strongly supported (r=.71, $p<.001$). To create this scale I first conducted a previous study that collected qualitative responses to the question "what makes for a good AAR?" The participants of this previous study were all active firefighters who had engaged in AARs as part of their job. Without any further prompts nearly all response focused on what supervisors should do during AARs to make them effective. Table 2 contains the themes of responses for this first study.

In the current study I worked with my advisor and another graduate student, both subject matter experts, to write items based on the themes identified from the first study. After many rounds of writing and reviewing we included them on the survey for this study. The items were all supervisor-focused good meeting practices and were expected to create a unidimensional factor structure. An exploratory factor analysis showed that the items did factor together in this manner thus making it appropriate to treat them as one scale.

Beyond the hypothesis I was also interested in the specific behaviors that drove safety climate most strongly. To do this I examined the correlations of each item to safety

climate and the unique variance (beta weights) accounted for by each item holding all other items constant. Nearly every item had a strong relationship to safety climate and all were statistically significant ($p<.001$). The two weakest correlations were "talks about what went wrong during the call" (r=.47, $p<.001$) and "points out funny things that happened during the call" (r=.45, $p<.001$). The former was likely and issue of item wording. Recall that this was the item that had the weakest factor loading as well. However, a similar item "discusses what we could have done better during the call" had a strong factor loading and a strong correlation to safety climate. This supports the idea that "talks about what went wrong during the call" is a poorly worded item. It includes the word "wrong" in the item and that could be uniquely affecting how it is interpreted. The latter item about humor may not have loaded well because it is not directly related to AAR effectiveness. It is unclear by what mechanism discussing funny incidents during a call would drive safety climate attitudes.

The strongest correlations were also the strongest unique drivers of safety climate (and the only three items that were significant when taking all other items into account). These were "provides clear direction for the meeting" ($b$=.18, $p<.05$), "starts the meeting promptly after the call" ($b$=.14, $p<.05$), and "points small things crew members experienced so that others can learn" ($b$=.19, $p<.05$). While all the items had an relationship to safety climate, these three seem to focus on group learning and holding a structured meeting.

Supervisor AAR Behavior, Perceived Supervisor Trust, and Safety Climate

The final hypothesis was that perceived supervisor trust would mediate the relationship between supervisor AAR behavior and safety climate. This hypothesis was

partially supported. I argued that supervisor behaviors during AARs would build perceptions of trust that would in turn improve safety climate. Partial mediation was supported suggesting a powerful mechanism to improve perceptions of managerial trust- an area that Collinson (1999) and Geller (1998) argue is incredibly hard to improve upon. Engaging in these behaviors during AARs can act as a first step towards building trust, improving safety climate, and ultimately, reducing the number of accidents in the workplace in a high risk organization.

# CONCLUSION

Taken together this paper focused on the key antecedents to safety climate in the context of AARs taking place in high risk organizations. There were a few themes that stood out. These are 1) the importance of AAR quality over AAR quantity, 2) the first attempts at linking behavioral integrity to safety climate, 3) the importance of perceived supervisor trust, and 4) the use of social exchange theory as a mechanism explaining attitude formation in groups.

AAR quality through supervisor AAR behavior and behavioral integrity was a valuable concept that should be explored further. It is likely that quality, however measured, is truly the main relationship driving safety climate in AARs. How frequently these high quality AARs occur should be considered a moderating variable. Future research would benefit from exploring ways to measure AAR quality.

One avenue I recommend is somehow combining supervisor behaviors with their perceived behavioral integrity. That is, does a supervisor hold themselves accountable to the good meeting practices, safety policies, and safety procedures they ask their direct reports to follow? If so, then their perceived behavioral integrity will be improved (Simons, 1999) and improvements in safety climate ought to be seen. It is likely that the future of research on behavioral integrity and safety climate will hinge on identifying the actual behaviors supervisors are engaging in.

Perceptions of trustworthiness will also prove to be a valuable avenue of future research. This study supported the work of Collinson (1999) who found qualitative evidence for the idea that trust perceptions were a driving force in attitudes and behaviors about safety. The theorized mechanism here is social exchange theory (Blau, 1964).

Trustworthy supervisors are “repaid” in high risk contexts with improved levels of safety climate. Trust, in fact, appears to be a stronger driving force than leader supportiveness as measured by LMX and proposed by Hofmann & Morgeson (1999).

Of use to practitioners this study provides specific leadership behaviors that supervisors can engage in during AARs. These behaviors should enhance the quality of AARs and the level of safety climate in the group. This increase in safety climate will have a real, measurable relationship to important safety outcomes like accident rates. Truthfully, it is for this reason that I as a researcher find this area of study so compelling. I am, in a small way, uncovering ways to keep people in dangerous jobs safe. While the relationship may be small over time it may mean the difference between someone getting seriously injured or not. It could even mean the difference between life and death.

This study is not without its limitations. Two stand out as noteworthy. The first is the relatively small number of cases used for the analyses. The sample size was 69 intact groups. This is relatively small for social science standards and pushed the limits of statistical power. Indeed, it appeared that hypothesis 4b failed to be supported for this very reason. A larger sample size, while difficult to obtain, would improve this study.

The second limitation is the fact that these data were collected at one time. Without a time 1 time 2 set up it is not appropriate to make causal statements. However, considering the strong theoretical backing for each hypothesis I do not believe this is as much of a limitation as it could be. In the case of safety climate, especially, there truly appears to be some causal mechanisms at play (Zohar, 2008). It is appropriate to discuss it as an outcome variable being affected by supervisor behaviors and direct report attitudes. Overall, this study has moved both theory and practice forward by identifying

the key antecedents, relationships, and mechanisms that drive safety climate on the group level in high risk environments.

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