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Safety specific transformational leadership, safety motivation and personal protective equipment use among firefighters

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Abstract

Personal protective equipment (PPE) use, although normally the last line of preferred hazard control, is vital to protecting firefighters. It is vital that research identify factors that positively influence firefighter behaviors associated with PPE use. Data were collected from 742 career firefighters working for metropolitan fire departments in both the eastern and western United States. Structural equation modeling was used to assess the hypothesized model and relationships between safety-specific transformational leadership, safety motivation and effective use of personal protective equipment. Safety-specific transformational leadership was positively associated with firefighter safety motivation and safety motivation was positively associated with personal protective equipment use. There was also a significant direct relationship between safety-specific transformational leadership and personal protective equipment use. Transformational leadership has not been an emphasis in the fire service because of its hierarchical structure and paramilitary-like traditions. Current fire service stakeholders have called for changes in leadership strategies and the overall culture within the fire service. This research provides additional evidence that safety-specific transformational leadership can bolster safety motivation among firefighters and can result in enhanced safety performance, including the proper and effective use of personal protective equipment.

Keywords

Firefighter; Safety; Personal protective equipment; Transformational leadership; Safety motivation

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1. Introduction

Although the use of personal protective equipment (PPE) as a means to protect workers is often considered the least preferred method of controlling hazards in the hierarchy of controls (OSHA, 2016), its use is often necessitous in environments and situations that cannot be fully controlled. This is particularly the case during firefighting operations. For example, firefighters must use gloves when exposed to bloodborne pathogens, must maintain and don self-contained breathing apparatus (SCBA) for breathable air in hazardous environments and must wear protective gear to prevent burns and to protect against heat exposures. These are only a few examples of the many active measures associated with PPE that require firefighter action for self-protection.

The effective use of PPE is a longstanding safety issue. Personal protective equipment utilization by individuals is considered to be an active countermeasure and requires individual action every time. Users must know the inherent limits of PPE and they must know how to use the equipment correctly. Motivation for self-protective behavior is thus central in this safety context.

While most firefighters likely understand the importance of PPE, firefighters often do not effectively use PPE (Kahn et al., 2012; Kahn et al., 2014; Kunadharaju et al., 2011; Maglio et al., 2016). Non-compliance or ineffective use has been attributed to factors such as firefighter identity, goal seduction, situational aversion to avoid ridicule and harassment from peers (Kahn et al., 2012; Kahn et al., 2014; Maglio et al., 2016). This is further complicated by the fact that firefighting is a rather unique occupation in that the firefighters' job is not to avoid the hazard but to confront it directly and suppress it. In addition, longstanding traditions within this occupation emphasize bravery, heroism, and self-sacrifice. Societal expectations further reinforce these expectations.

Given these challenges and competing cultural norms, it is important to identify factors that can positively influence safety motivation and PPE use among firefighters. Safety-specific transformational leadership (SSTL) may be one of these factors that could influence safety motivation and effective and proper PPE utilization, as Andriessen (1978) found that safety motivation is largely determined by leadership and safety standards of the leader. SSTL incorporates aspects of transformational leadership, but underscores occupational safety (Barling et al., 2002). SSTL was developed to include items related to the four primary components of transformational leadership (i.e., idealized influence, inspirational motivation, intellectual stimulation and individualized consideration) plus contingent reward (Barling et al.), which have implications for safety-specific leadership (Kapp 2012; Hoffmeister et al., 2014). SSTL is generally examined as a justified unidimensional index, which was validated during its inception by Barling and colleagues (Barling et al.).

SSTL is associated with enhanced occupational safety outcomes, including safety climate, safety consciousness and safety behaviors (Barling et al., 2002; Clarke and Ward, 2006; Kelloway et al., 2006; Mullen et al., 2011). Positive significant relationships between SSTL, safety climate and safety behaviors have also been observed within the fire service (Smith et al., 2016). Given the influence on general safety compliance behaviors, it is believed that

specific compliance-oriented behaviors, such as PPE use, would similarly be influenced by SSTL. The mechanism in which SSTL influences safety behaviors outside of safety climate has not been thoroughly explored and safety motivation has been minimally assessed as part of the theoretical framework linking SSTL to safety behaviors, particularly PPE use. Safety motivation refers to an individual's willingness to exert effort to enact safety behaviors (Neal & Griffin, 2006). SSTL may bolster this willingness or safety motivation, similar to safety climate, in the context of social exchange theory and reciprocity (Gouldner, 1960; Blau, 1964). This framework suggests that concern for employee safety by management and the organization's leaders motivates the employee to perform the desired performance or safety behaviors, because of inherent reciprocity principles in social exchange relationships (Griffin & Neal, 2000; Clarke, 2013; Zohar et al., 2015).

The purpose of this study is to assess the relationships between safety specific transformational leadership (SSTL), safety motivation and PPE use among firefighters. Particularly, the present study aims to assess whether SSTL is positively associated with safety motivation and PPE use and whether safety motivation is associated with PPE use. SSTL is posited to be positively associated with safety motivation (hypothesis 1) and safety motivation is posited to be positively associated with effective and compliant PPE behaviors (hypothesis 2). Based on prior research linking SSTL directly to safety performance outcomes including general safety compliance behaviors, SSTL is posited to be positively associated with effective and compliant PPE behaviors (hypothesis 3), suggesting a partial mediation model accounts for the associations between these factors.

Despite a broad literature illustrating the impact of transformational leadership on motivation (Hater & Bass, 1988; Judge & Piccolo, 2004; Bass & Riggio, 2006; Ilies et al., 2006), research in the context of safety associated with SSTL has not frequently included an exploration of its impact on safety motivation. SSTL has instead usually been associated with positive influences on safety climate (Barling et al., 2002; Clarke & Ward, 2006; Clarke, 2013; Kelloway et al., 2006; Mullen & Kelloway, 2009; Smith et al., 2016). Thus, this exploration is a novel investigation into the relationship between SSTL and safety motivation. The study is also considered novel, as it examines the direct impact of SSTL on PPE use. SSTL has been shown to directly influence safety behaviors in prior research (Christian et al., 2009; Clarke, 2013). However, safety behavior outcomes in these studies have not specifically focused on PPE use among firefighters.

2. Methods

2.1. Data collection

Participants include firefighters from two similar city fire departments: one in the eastern United States (US) and the second in the western US. The eastern US department has approximately 1000 sworn firefighters working at 35 stations, responding to approximately 100,000 calls per year. The western US department has approximately 700 sworn firefighters working at 33 stations, responding to approximately 91,000 calls per year. Both departments protect infrastructure and operations that include multiple hospitals, universities, professional sporting venues and an international airport. The mean age for

this study sample was 40.53 ($SD = 7.91$). Additional participant characteristics are detailed in Table 1.

Data were collected using an online survey administered through each department's training portal. Data from firefighters active on the fireground, who utilize personal protective equipment for their jobs, were included. Chiefs, at all levels, and administrative personnel were not included. The final sample included 742 firefighters, including 352 from the eastern US department and 390 from the western US department. This sample size exceeds the recommended minimum of 200 respondents for structural equation modeling analyses (Fan et al., 1999; Kline, 2005).

2.2. Measures

Items associated with three constructs, including safety specific transformational leadership (SSTL), safety motivation and personal protective equipment behavior, were included in this study. SSTL was assessed using a ten-item scale from Smith, Eldridge & DeJoy (2016), which was based on prior research by Barling et al. (2002). Sample items include "My immediate supervisor encourages me to express my ideas and opinions about safety at work," "My immediate supervisor behaves in a way that displays a commitment to a safe workplace and "My immediate supervisor expresses satisfaction when I perform my job safely." Items were assessed on a 5-point Likert-type scale from strongly disagree to strongly agree. Safety motivation was assessed using a three-item scale adapted from Neal and Griffin (2006). These items include "How often do you feel that it is worthwhile to put in effort to maintain or improve my personal safety," "How often do you feel that it is important to maintain safety at all times" and "How often do you believe that it is important to reduce the risk of accidents and incidents in firefighting?" Items were assessed using a 5-point Likert-type scale from almost never to almost always. Lastly, PPE behavior was comprised of three items associated with the effective and proper use of PPE in the fire service (NFPA, 2007). Items were rated on a 5-point Likert-type scale ranging from almost never to almost always. These items include "I correctly use appropriate personal protective equipment (PPE) during firefighting operations," "I correctly inspect all my PPE on a regular basis" and "I ensure my PASS device is fully functional prior to each use."

2.3. Analyses

Descriptive and preliminary analyses were completed using SPSS v.25. Pearson correlations for individual items were not at levels that would suggest problems with multicollinearity. As previously noted, SSTL is generally examined as a valid unidimensional index (Barling et al., 2002). Since the development of this measure, van Knippenberg and Sitkin (2013) called into question whether the unidimensionality of transformational leadership is appropriate, which may be applicable to SSTL. To explore whether SSTL should be examined as a unidimensional construct or if multiple factors related to transformational leadership should be examined in the model, the 10 items associated with SSTL were factor analyzed using Principal Axis Factoring and Varimax rotation. An examination of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Sphericity Tests confirmed the data were appropriate for factor analysis. The result of the KMO was 0.952, which is considered "marvelous" and worthy of factoring (Kaiser, 1974). The significance of

Bartlett's test at $\chi^2 = 5771.80$, $df = 45$, $p < 0.001$, also indicated that the original correlation matrix was not an identity matrix and met the criteria for factor analysis (Bartlett, 1950). Factor analysis of the 10 SSTL items yielded a one factor solution based on an analysis of the scree plot and an assessment of factors with eigenvalues greater than 1.0. The one factor explained 69.98% of the variance. Thus, the unidimensional measure of SSTL was confirmed and utilized in the model.

Descriptive statistics, Cronbach's alphas and correlations for latent constructs are reported in Table 2. For the purposes of this study and to assess our hypotheses, we conducted a structural equation modeling (SEM) analysis, using Mplus v. 7.2. SEM allows for the simultaneous assessment of the measurement model and the path analysis. Model fit was assessed against criterion established by Hu and Bentler (1999) and Marsh et al. (1988) using multiple fit indices including the comparative fit index (CFI), the root mean square error of approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMSR).

3. Results

The overall fit of the model was satisfactory: $\chi^2 = 531.55$, $df = 101$, $p < 0.001$, CFI = 0.95, RMSEA = 0.08, and SRMSR = 0.04. Values for CFI, RMSEA and SRMSR were within prescribed guidelines for satisfactory fit (Hu & Bentler, 1999; Marsh et al., 1988). Hypothesized relationships were assessed through an examination of the unstandardized path coefficients, standard errors and significance values. Hypothesis 1 was confirmed. SSTL was positively associated with safety motivation ($B = 0.24$, $SE = 0.03$, $p < 0.001$). Hypothesis 2 was confirmed. Safety motivation was positively associated with PPE behavior ($B = 0.20$, $SE = 0.03$, $p < 0.001$). Lastly, there was a direct effect between SSTL and PPE behavior. As such, the third hypothesis was confirmed. SSTL was positively associated with PPE behavior ($B = 0.07$, $SE = 0.02$, $p < 0.001$). Although supported, this relationship was not as strong as the relationship between safety motivation and PPE behavior. In addition to confirming the hypothesized pathways, we were able to illustrate the complexity of the measurement model. All items associated with the three latent factors significantly loaded onto their respective factors. These statistics are further presented in Table 3.

4. Discussion

The purpose of this study was to test a model that posited SSTL would be positively associated with safety motivation and that safety motivation would be positively associated with effective and compliant PPE behaviors. Further, it was posited that SSTL would have a direct relationship with and would be positively associated with effective and compliant PPE behaviors, suggesting a partial mediation model would best illustrate the associations between these factors.

The results of this study confirm our hypothesized model and relationships. An important finding was that SSTL was positively associated with safety motivation. Although there is a robust organizational and leadership literature associated with transformational leadership

and motivation, this relationship has not been thoroughly explored in the context of safety, particularly within the fire service, where safety is a critical aspect of the mission.

This study reiterates the importance of SSTL on enhancing safety outcomes, particularly with bolstering firefighter safety motivation, which in this context is the individual's willingness to exert effort to enact safety behaviors (Neal & Griffin, 2006). Safety motivation positively influenced PPE behavior, which is necessary to protect firefighters. SSTL also directly influenced PPE behavior indicating that SSTL and safety motivation can foster active measures and self-protective behavior. These delineated relationships have significant implications within high hazard industries, including the fire service, as PPE is often necessary to protect the overall health of users when significant hazards are encountered. Corrective measure recommendations made by the National Institute for Occupational Safety and Health in numerous firefighter fatality investigations recommended measures to provide and enhance the use of PPE to curtail future fatalities (Kunadharaju et al., 2011).

Results show the importance of positive leadership within the fire service. Although past traditions within the fire service suggest fire service leaders use more authoritarian or autocratic leadership strategies, because of its military-like structure, it was determined that more inspirational approaches to leadership, including safety specific transformational leadership, can be motivating and have direct effects on safety outcomes. This influence on active measures, required of firefighters, is also encouraging. Often, transformational leadership strategies encourage followers to achieve contextual or citizenship-type behaviors, which are important for the greater good of all involved. Without question, this is extremely important in the context of firefighting as firefighters need to protect their fellow firefighters and protect the public, but firefighters often forsake their own safety for the purpose of the mission. It was determined that SSTL had an impact on safety motivation and behaviors important for self-protection, particularly when it comes to efficacious use of personal protective equipment. Thus, transformational leadership strategies should be incorporated by the fire service to not only bolster citizenship behaviors, but to motivate firefighters to perform active measures or self-protective safety behaviors that will protect the firefighters themselves.

The present study is a basic exploration into relationships between the factors incorporated into the model. More research needs to be conducted within the fire service, particularly since firefighters are often injured or die in the line of duty at higher rates than many occupational groups. Additional research is needed to enhance firefighter safety. In the context of this study, additional research is needed to further explore other antecedents to safety motivation. Past research suggests that safety climate and safety motivation relationships should be explored as safety climate positively influences safety motivation among workers outside of the fire service (Neal et al., 2000; Griffin & Neal, 2000). Safety management practices and safety management systems should also be explored as these have been shown to influence safety motivation as well (Neal et al., 2000; Vinodkumar & Bhasi, 2010; Chen & Chen, 2014). Lastly, more clearly defined research related to motivation, particularly its identification and measurement in a safety context is needed. Multiple theoretical perspectives have been presented to explain safety motivation (Scott et

al., 2014; Griffin & Curcuruto, 2016) including intrinsic motivation, extrinsic motivation and motivation through social-exchange theory and reciprocity (Griffin & Curcuruto, 2016). The complex nature of safety motivation requires careful consideration, as it is a complex construct associated with many factors at many levels (individual, organizational, societal, etc.). Endeavors related to safety motivation can take many tracks with each examination providing insights and opportunities to initiate, strengthen, and/or leverage specific factors for specific safety behaviors leading to fewer occupational injuries and accidents (Christian et al., 2009; Clarke, 2013). In order to better understand safety motivation and its relationships, continued research is needed to determine why employees are motivated to work safely (Scott et al., 2014).

Although the focus of this research is on PPE, other behavior outcomes associated with active measures could be explored to ensure these findings can be generalized to additional self-protective behaviors. Of particular interest would be the use of seat belts among firefighters when riding in fire apparatus. Non-use has been a significant problem and major cause of firefighter injuries and fatalities (Peterson et al., 2009; Donoughe et al., 2012; Fahy et al., 2018). Further, future studies should also incorporate safety knowledge into the model. We did not collect data associated with safety knowledge, but it has often been cited as another factor, along with safety motivation, that influences safety outcomes (Griffin & Neal, 2000; Vinodkumar & Bhasi, 2010).

As with all research, there are some limitations that need to be considered when interpreting the findings of this research. Data were cross-sectional, which limits our ability to indicate causation. Further, data were collected from full-time, career firefighters working for metropolitan departments, which impacts generalizability to career firefighters in disparate settings and volunteer firefighters. These analyses only included data that were collected from survey research, which could potentially result in mono-method biases. Lastly, it should be noted that although the posited model was verified and supported, other possible factors might influence motivation and safety behavior outcomes. As previously noted, future research is suggested to assess additional models that include other antecedents to safety motivation and safety behavior.

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Table 1

Demographic Information.

	Eastern US Fire Department	Western US Fire Department
Gender		
Male	334	373
Female	12	13
Race		
Black or African American	97	13
Asian	16	26
American Indian or Alaskan Native	3	8
Native Hawaiian or Pacific Islander	3	10
White	193	234
Other	29	71
Hispanic Ethnicity		
Yes	30	82
No	313	299
Marital Status		
Single	67	65
Divorced/Separated	24	28
Widowed	1	0
Married/Living w/Partner	254	293
Education		
Some High School	31	7
High School Graduate or GRE	123	112
Some College or Technical/Vocational		
Training	87	132
Associate's Degree	97	123
Bachelor's Degree	11	12
Postgraduate Coursework or Degree		
Rank		
Firefighter	206	282
Company Officer	136	103
Tenure (Years with Department)		
Less than 1	21	19
1–3	62	40
4–9	74	105
10–15	77	100
16–20	29	6
21–25	41	83
More than 25	43	31

Table 2

Latent factor descriptive statistics, Cronbach's alphas and correlation matrix.

	SSTL	Safety Motivation	PPE
Items (#)	10	3	3
Cronbach's α	0.95	0.85	0.76
M	3.91	4.60	4.75
SD	0.711	0.54	0.45
SSTL	1.000		
Safety Motivation	0.29***	1.000	
PPE	0.26***	0.41***	1.000

 $p < 0.001$.

Table 3

Model statistics.

Path	Unstandardized Path Coefficient	SE	t	p
Safety Specific Transformational Leadership (SSTL)				
SSTL1	1.000	0.00	–	–
SSTL2	1.101	0.06	17.76	< 0.001
SSTL3	1.173	0.05	24.58	< 0.001
SSTL4	1.151	0.05	25.17	< 0.001
SSTL5	1.242	0.05	23.27	< 0.001
SSTL6	1.234	0.05	23.07	< 0.001
SSTL7	1.270	0.05	24.94	< 0.001
SSTL8	1.198	0.05	25.55	< 0.001
SSTL9	1.310	0.00	23.35	< 0.001
SSTL10	1.032	0.05	21.46	< 0.001
Safety Motivation				
SM1	1.000	0.00	–	–
SM2	1.157	0.06	20.64	< 0.001
SM3	1.118	0.05	21.08	< 0.001
PPE				
PPE1	1.000	0.00	–	–
PPE2	2.095	0.15	14.09	< 0.001
PPE3	1.887	0.14	14.02	< 0.001
To Safety Motivation from SSTL	0.240	0.03	7.34	< 0.001
To PPE from Safety Motivation	0.202	0.03	7.36	< 0.001
To PPE from SSTL	0.074	0.02	4.20	< 0.001