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Firefighters' leadership and well-being in rural fires: study in virtual reality environments

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Keywords

Firefighters; leadership; well-being; rural fires; virtual reality.

Abstract

In this study, we analysed the effects of team leadership style on the well-being of firefighter teams operating under conditions of a simulated rural fire. Twenty teams of firefighters (composed of five elements each) took part in a computer-based fire-fighting simulation task and were randomly assigned to one of two conditions (leadership style: directive vs. empowering). Our results showed that directive leadership style was negatively associated with team members levels of stress and anxiety, while an empowering leadership style did not have a significant effect on team members levels of stress and anxiety. The distinct effects of team leadership style remain unchanged when we controlled for the levels of stress and anxiety before the simulation. Through moderated regression analyses we observed that the effect of directive leadership styles in reducing stress and anxiety was stronger for participants with higher levels of previous stress and anxiety. Implications for theory and practice are discussed.

1. Leadership and well-being among firefighters

Firefighters have a high-strain occupation, since physical danger and psychological stress are part of their daily lives (Prati, Pietrantoni, & Cicognani, 2010). In this study, we draw from the theory of leadership, defined as a social influence process where leadership behaviors affect followers' outcomes, to build an understanding of the different ways firefighters react to the constant disruption and ongoing strain involved in their work, focusing specifically on responses that lead to positively adaptive outcomes. We have considered leadership a contextual variable that can explain this positive result because leaders have the potential to be a buffer against work stressors (Harms, Credé, Tynan, Leon & Jeung, 2016), thus we expect to contribute to the literature, by empirically investigating leadership behaviors that explain when and how firefighters positively adapt to stressful situations.

2. Virtual reality

The development of virtual environments and computer game technologies made it possible to create scenarios in 3D graphic environments and new learning contexts based on virtual simulation tools for the training of incident commanders (Wijkmark & Heldal, 2020). The scenarios can have different levels of complexity and firefighters can move and interact in the virtual environment, make decisions, and observe the consequences of decisions taken.

Virtual reality scenarios challenge firefighters and make them feel involved and react as if they were in real events (Reis & Neves, 2019). Virtual reality simulation enables to create large-scale events that would be extremely difficult and even dangerous to recreate in a live exercise (Boosman, Lamb & Verhoef, 2015).

3. Hypothesis

In this study, we wanted to verify which leadership style contributed better to the well-being of subordinates, and therefore raised the following hypotheses:

1) the empowering leadership style is negatively associated with stress and anxiety levels during intervention action in a simulated rural fire situation.

2) the directive leadership style is positively associated with stress and anxiety levels during an intervention in a simulated rural fire situation;

3) the effect of the empowering style (3.a) and the directive style (3.b) is stronger in relation to firefighters who at the beginning of the intervention had higher levels of stress and anxiety when compared to those who at the beginning of the intervention had lower levels of stress and anxiety.

4. Procedure and sample

Twenty teams of firefighters (composed of five elements each) participated in the simulation exercise where they hat to confront a simulated rural fire scenario. Simulation studies enable us to manipulate contextual conditions difficult to access in real environments (*e.g.* extreme conditions in a rural fire) and to measure their impact on the deployment of participants well-being.

We used a simulation exercise similar to the ones used in firefighters' training and participants were randomly assigned to teams of five individuals to fight a massive extent rural fire. Teams were also randomly distributed through 2 experimental conditions in which leadership style [i.e. empowering leadership; directive leadership] was manipulated.

To induce a high-demand situation, we presented participants with disruptive conditions in the scenario. To manipulate leadership behavior, participants in each team answered a questionnaire to measure their style as leaders (empowering vs. directive), and the participant with the higher score on either empowering or directive style was assigned the leading role (team leader). Next, the leader was given a script with the behaviors considered to be the most effective according to the condition he was assigned to (directive or empowering). Each team was assigned to one of the two leadership style conditions.

Pre and post simulation stress and anxiety were measure with 6 and 5 items, respectively, from the Portuguese version (EADS-21; Pais-Ribeiro, Honrado & Leal, 2004) of the Depression Anxiety Stress Scales (Lovibond & Lovibond, 1995).

5. Results

To test our hypothesis that directive and empowering leadership have a different impact on subordinates' levels of stress and anxiety in a firefighting situation, we conducted a regression analysis. In addition, to test the hypothesis that the behavior of the leader has more impact when subordinate levels of anxiety and stress before the situation were high, we conducted a moderated regression.

Table 1. Direct and interaction effects of leadership style and previous stress and anxiety levels on stress and anxiety after the simulated firefighting episode.

Variable	Model 1 Stress as outcome	Model 2 Anxiety as outcome
Empowering leadership	.278	.394
Directive leadership	-.494*	-.578**
Previous stress	.251*	
Previous anxiety		.417**
Directive leader X Previous stress	-.258**	
Directive leader X Previous anxiety		-.234*
R2	.170**	.277**

* $p < .05$; ** $p < .01$

As we can see in Table 1. team leader's directive leadership style had a significant direct negative effect on subordinates' levels of stress and anxiety after the simulated firefighting episode. A directive leadership style

seems to be associated with reduced levels of stress and anxiety in subordinates, measured immediately after they engaged in firefighting simulated with a VRX simulator used to train firefighters. Opposite to our expectations, team leaders empowering leadership style did not have a significant effect on the levels of stress and anxiety of individuals after the simulated firefighting episode.

In Figure 1. we plotted the interaction between team leader's directive leadership style and subordinates stress levels measured before the episode of simulated firefighting. As shown in Figure 3, individuals led by a directive leader exhibited lower levels of stress after the performance than they reported before. Moreover, this stress-reducing effect was stronger for subordinates with higher stress levels in the beginning, thus supporting Hypotheses X.

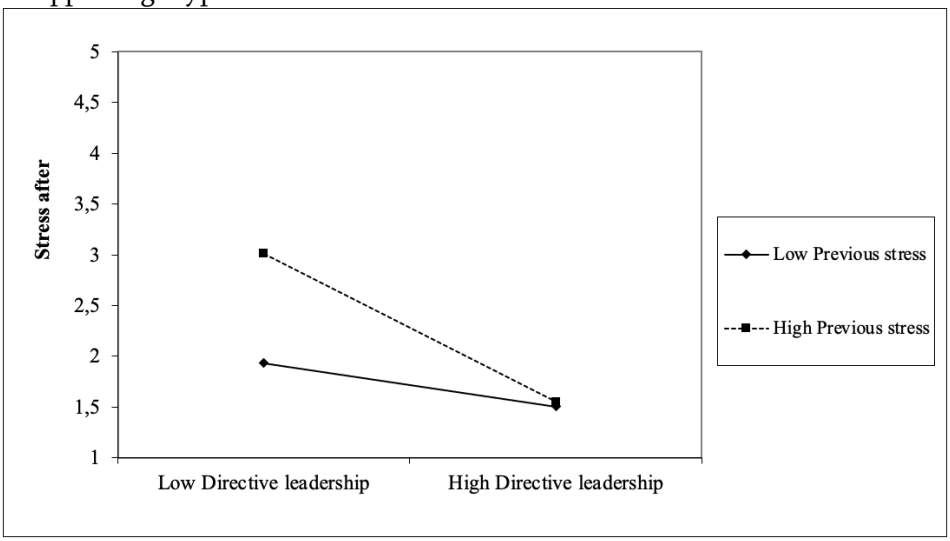

Figure 1. Interactive influence of previous stress and directive leadership style on stress after the firefight.

In Figure 2. we plotted the interaction between team leader's directive leadership style and subordinates' anxiety levels measured before the episode of simulated firefighting. As shown in Figure 3, individuals led by a directive leader exhibited lower levels of anxiety after performance than they reported before. Moreover, this anxiety reducing effect was stronger for subordinates with higher anxiety levels in the beginning, thus supporting Hypotheses X.

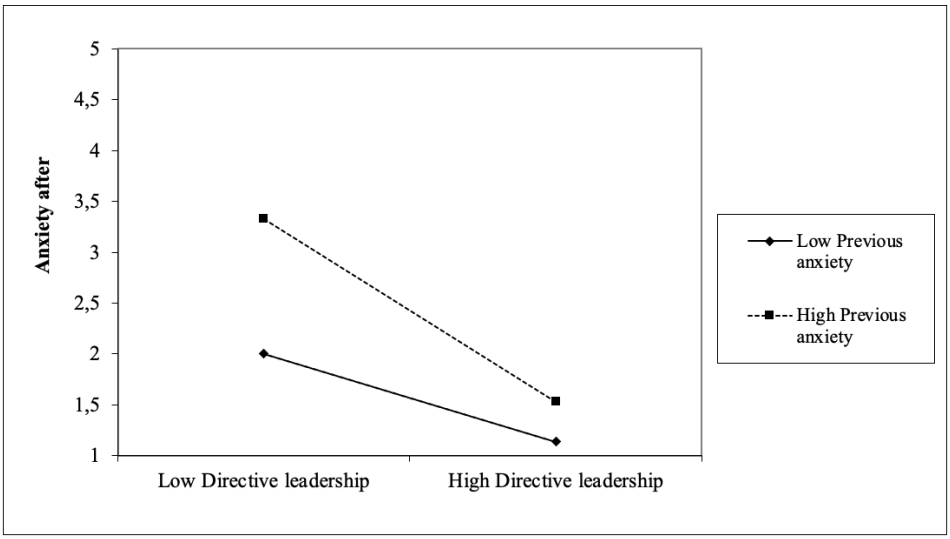

Figure 2. Interactive influence of previous anxiety and directive leadership style on anxiety after the firefighting episode.

6. Discussion

Directive leadership is associated with a leader's positional power and is characterized by behaviors aimed at actively structuring subordinates´ work by providing clear directions and expectations regarding compliance with instructions (Somech, 2006). Directive leaders help followers resolve task and role ambiguity and provide external monitoring and feedback on their performance, reducing process loss and allowing the team to execute decisions more quickly (Lorinkova et al. 2013; Sagie, 1996).

Empowering leadership, on the other hand, involves sharing power with subordinates and raising their level of autonomy and responsibility, and it manifests through behaviors like encouraging team members to express opinions and ideas, promoting collaborative decision-making and information sharing (Arnold et al., 2000; Yun et al., 2005). Although empowering leadership tends to enhance team efficacy and commitment through psychological ownership of the task and improved coordination and teamwork (Zaccaro et al., 2001) in extreme situations where lives are at risk and good decisions must be made rapidly assigning tasks and providing clear directions seems to work better to solve the problem and consequently reducing the levels of anxiety and stress triggered by an extreme situation like a fire.

Previous research has confirmed the positive influence of empowering leadership on individual performance (Zhang & Bartol, 2010) and on the development of project and action teams (Kozlowisky et al., 1999). However, other studies have demonstrated that empowering leadership comes at an initial performance cost, showing to be more effective in later developmental phases, mainly through learning about their task environment and each other's areas of expertise to develop team mental models of how to integrate their efforts, gain collective efficacy and commitment through psychological empowerment, and foster routines to coordinate their behaviors (Lorinkova et al., 2013; Kozlowski et al., 1999; Sharma & Kirkman, 2015).

Although an empowering leadership style may be more appropriate for development of shared mental models and routines for coordination and learning necessary to adapt to complex and changing environments, the consequent team development and readiness requires time (Lorinkova et al., 2013). For teams with short-term or emergent engagements and teams facing emergency situations (e.g., surgical, police, military, and firefighter teams), a directive style may be most appropriate, as teams must be able to immediately perform at a high level and cannot afford the performance delays learning errors associated with empowered teams (Sims et al., 2009; Yun et al., 2005).

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