KU LEUVEN

FACULTY OF PSYCHOLOGY AND
EDUCATIONAL SCIENCES

RESEARCH UNIT OF OCCUPATIONAL & ORGANIZATIONAL
PSYCHOLOGY AND PROFESSIONAL LEARNING

Leadership and Safety Behavior in Air Traffic Control and Beyond

Anna Katharina Schopf

Doctoral thesis offered to obtain the degree of
Doctor of Psychology (PhD)

Supervisor: Prof. dr. Jeroen Stouten
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Summary

Safety behavior is critical in air traffic control (ATC) and other high-risk environments due to the far-reaching risks a lack of safety behavior entails in terms of physical harm, social, and economic consequences. The literature shows that one of the main antecedents of safety behavior is leadership. Yet, little research on the relationship between leadership and safety behavior has been conducted in ATC. The first aim of this dissertation is to examine this relationship. For that purpose, in a first study, diary study data was obtained from employees in ATC. Supervisors' servant leadership, support for safety, and leader-member exchange did not show a relationship with employees' safety citizenship behavior or safety compliance, reflecting respectively safety behavior that is prescribed by the job and safety behavior that facilitates a safety-supportive environment without being prescribed by the job. Moreover, unexpectedly a *negative* relationship between supervisors' trustworthiness and employees' safety citizenship behavior was found. The results suggest that in the ATC context different processes may be of importance than in other industries, or that the right conditions may need to be created for ATC supervisors' leadership to relate to employees' safety behavior. Moreover, the study emphasizes the need for leaders to take up the "leader role", as opposed to being primarily focused on administrative processes, in order to see relevant outcomes of leadership.

In a second study, the relationship between transformational and transactional leadership on the one hand and employees' cognitive task performance on the other hand was examined. Cognitive task performance is important for safety performance in ATC, but also more generally for employees' job performance. This study applied and tested the conservation of resources (COR) theory of Hobfoll (1989) regarding cognitive resources with data from employees who filled in a survey and performed cognitive tasks. The results indicated that the relationship between leadership and employees' cognitive task performance may be negligible and unexplainable by COR theory.

A third study explored the role of situational factors in determining safety compliance and safety performance, as situational factors may well play a significant role in spite of being widely neglected in the safety literature. Drawing on bounded ethicality research, cognitive load and perceived responsibility for safety (as situational factors) were expected to influence individuals' safety compliance and performance. Moreover, the moderating role of individuals' personality was investigated. Based on experimental data, no evidence was found for the hypothesized main and interaction effects of the situational factors, yet evidence for a moderating role of personality was found. This implies that depending on individuals' personality, situational factors may need to be considered to increase safety compliance and performance. Overall, this dissertation highlights the importance of context with regards to safety behavior and its relationship with leadership.

Samenvatting

Veiligheidsgedrag is cruciaal in de luchtverkeersleiding en andere risico-omgevingen, aangezien een gebrek ervan kan zorgen voor fysieke, sociale, en economische schade. De literatuur toont dat leiderschap één van de belangrijkste antecedenten van veiligheidsgedrag is. Er bestaat echter weinig onderzoek naar de relatie tussen leiderschap en veiligheidsgedrag in de luchtverkeersleiding. Het eerste doel van dit proefschrift is deze relatie te onderzoeken. Daartoe werden er in een eerste studie dagboek-gegevens verzameld van werknemers uit de luchtverkeersleiding. Dienend leiderschap, veiligheidsondersteuning door de leidinggevende, en *leader-member exchange* toonden geen relatie met *safety citizenship behavior* (veiligheidsbevorderend gedrag dat niet voorgeschreven is door iemands functie), noch met *safety compliance* (veiligheidsbevorderend gedrag dat *wel* voorgeschreven is door iemands functie). Daarenboven werd onverwacht een *negatieve* relatie gevonden tussen de betrouwbaarheid van leidinggevenden en het *safety citizenship behavior* van werknemers. De resultaten suggereren dat in de luchtverkeersleidingscontext mogelijks andere processen van belang zijn dan in andere sectoren, of dat de juiste voorwaarden moeten worden gecreëerd om leiderschap te laten samenhangen met het veiligheidsgedrag van werknemers. Bovendien benadrukt deze studie de noodzaak voor leidinggevenden om de "leidersrol" op te nemen, in tegenstelling tot een focus op administratieve processen, om relevante uitkomsten van leiderschap te kunnen observeren.

In een tweede studie werd de relatie tussen transformationeel en transactioneel leiderschap enerzijds en de cognitieve taakprestatie van werknemers anderzijds onderzocht. Cognitieve taakprestatie is belangrijk voor de veiligheidsprestatie in de luchtverkeersleiding, maar ook voor prestaties van werknemers in het algemeen. Deze studie paste de *conservation of resources* (COR) theorie van Hobfoll (1989) toe op cognitieve hulpbronnen (*"resources"*) en testte de hypotheses met data van werknemers die een enquête invulden en cognitieve taken uitvoerden. De resultaten suggereerden dat de relatie tussen leiderschap en cognitieve taakprestaties van werknemers verwaarloosbaar is en niet te verklaren valt door de COR theorie.

Een derde studie onderzocht de rol van situationele factoren als voorspeller van veiligheidsnaleving en -prestatie, aangezien situationele factoren hier een belangrijke rol zouden kunnen spelen, terwijl ze weinig aandacht krijgen in de veiligheidsliteratuur. Gebaseerd op onderzoek over *bounded ethicality* werd verwacht dat cognitieve belasting en gepercipieerde verantwoordelijkheid voor veiligheid (als situationele factoren) een invloed hebben op veiligheidsnaleving en -prestatie. Bovendien werd de modererende rol van persoonlijkheid onderzocht. Experimentele gegevens leverden geen evidentie op voor de vermoedde hoofd- en interactie-effecten, maar wel voor een modererende rol van persoonlijkheid. Dit impliceert dat er afhankelijk van iemands persoonlijkheid mogelijks rekening dient gehouden te worden met situationele factoren om de veiligheidsnaleving en -prestatie te verbeteren. In het algemeen onderstreept dit proefschrift het belang van de context voor wat betreft veiligheidsgedrag en de relatie tussen leiderschap en het veiligheidsgedrag van werknemers.

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Chapter 1:

General Introduction and Literature Review

Introduction

"Safe behavior poses a managerial challenge" (Zohar, 2002a, p. 156). This intriguing statement is based on the worrying finding that unsafe behavior still prevails in the workplace (Zohar, 2002a). It is important that this issue is addressed, as unsafe behaviors may have dire consequences. *Safety behaviors*, being "any workplace actions or practices that affect the degree to which persons in and immediately surrounding the workplace (e.g., employees, customers, and community members) are free from physical threat or harm" (Beus & Taylor, 2018, p. 403), have a small to moderate but consistent relationship with safety outcomes, such as occupational injuries and accidents (e.g., Clarke, 2010, 2013). On top of potential physical harm, there are also negative organizational, social, and economic consequences (Burke et al., 2002; Veltri et al., 2013; Zohar, 2002b). For instance, airplane accidents can claim many lives, are costly, draw the public's attention, and lead to a tremendous decrease in associated entities' reputations and future customer amounts (Liao, 2015; Madsen, 2013).

The importance of safety behavior also warrants the growing research interest in its antecedents (Beus et al., 2016). One antecedent that has received scholarly attention is leadership (Donovan et al., 2016; Hofmann et al., 2017). As Hoffmeister et al. (2014) put it: "although leadership may not be the only determinant of workplace safety, it is an important one" (p. 76). However, most leadership-safety research is conducted in the manufacturing and construction industry (Donovan et al., 2016), and research on the relationship between leadership and safety in the aviation industry is missing (Donovan et al., 2016; Lofquist, 2010). This dissertation aims to help filling this gap by investigating the role leadership plays in the context of air traffic control (ATC). The functions of ATC are to "promote the safe, orderly, and expeditious flow of aircraft in flight or operating in the maneuvering area of an airport" (Ek & Arvidsson, 2012, p. 12). As such, safety is critical for this industry,

and supervisors' leadership is likely to play an important role, as it could be crucial for maintaining safety awareness, creating openness to discuss safety-related topics, and anticipating unsafe situational factors. After all, "effective safety leadership is particularly important in the context of major hazard organisations because… failures and errors can have catastrophic consequences" (Lekka & Healey, 2012, p. 4).

Therefore, in the first study, this dissertation aims to shed light on the relationship between different leadership aspects and employees' safety behavior in ATC. Secondly, this dissertation examines whether leadership styles influence employees' cognitive performance, in terms of attention, working memory, and problem-solving, which is particularly important for employees working in ATC. The third study contains empirical evidence concerning the role situational factors play in determining safety behavior. This is important to investigate, as while situational factors have widely been neglected in the safety literature, they may well play a crucial role in safety. If they do, they may interact with leadership influences, making them important for leaders to take into account.

From a practical point of view, this dissertation aims to contribute to the knowledge on which leadership characteristics are needed in ATC to enhance safety, which situational factors need to be taken into account, and how ATC supervisors can be supported in their role. Currently, ATC supervisors are faced with an increasingly complex context and growing demands due to technical developments, more interactions with external stakeholders, and new rules and responsibilities, for example as defined in the EU regulation on requirements for air navigation service providers (ANSPs; 2017). Moreover, current knowledge on how to support supervisors in ATC and how they influence air traffic safety (ATS) employees is very limited. Therefore, this dissertation was accompanied by industry interest and was sponsored by the "Belgocontrol Chair on Human Factors and Leadership in Aviation

Safety". The founder of this chair, formerly Belgocontrol, now called skeyes, is the Belgian ANSP, which is responsible for the safe and efficient management of the movements in the Belgian lower civil airspace. It is an autonomous public enterprise with 872 employees, about 300 of which are ATS employees and supervisors (skeyes, 2019).

Before discussing the different chapters of this dissertation and their objectives more in detail, the section below elaborates on what is already known from the literature about the topic of safety and its antecedents, with a particular focus on leadership. These topics are discussed both in general and, in separate sections, for ATC specifically.

Literature Review on Safety and Leadership

Safety and Safety Behavior[1]

Workplace safety can be defined as "an attribute of work systems reflecting the (low) likelihood of physical harm—whether immediate or delayed—to persons, property, or the environment during the performance of work" (Beus et al., 2016, p. 353). This topic has gained considerable research attention during the last years (Beus et al., 2016). Scholars usually focus on two aspects that are indicative of workplace safety: safety outcomes, which are mostly studied in terms of accidents (e.g., Beus et al., 2016), injuries (e.g., Beus et al., 2010), or safety incidents (e.g., Payne et al., 2010), and safety behavior.

Different conceptualizations of safety behavior are used in the literature. Most often, scholars distinguish between safety compliance and safety participation,

[1] I wish to acknowledge that the field of workplace safety is multi-disciplinary, including study fields such as law, engineering, ergonomics, toxicology, business/management, human resource management, and psychology (Fan et al., 2020; Hofmann et al., 2017). While this dissertation tries to take into account other perspectives, it has been developed from a business and psychology lens.

as initially described by Griffin and Neal (2000). *Safety compliance* refers to carrying out prescribed safety activities, such as wearing protective clothing or, in ATC, keeping appropriate distances between aircraft. *Safety participation* on the other hand refers to contributing to safety in ways that are not prescribed by the job, for example by making suggestions on how to improve safety (Griffin & Neal, 2000). This differentiation is based on performance theory (Campbell, 1990; Campbell et al., 1993) and parallels the differentiation between task performance (prescribed behaviors) and contextual performance (discretionary behaviors). Hofmann et al. (2003) added *safety citizenship behavior* as a separate concept that is akin to safety participation, akin to the broader performance literature, where scholars often use "organizational citizenship behavior" when referring to contextual performance. Safety citizenship behavior consists of six dimensions: safety-related helping, stewardship, initiating safety-related change, safety voice, civic virtue (keeping informed about safety issues), and whistleblowing (Hofmann et al., 2003). Some authors divide safety citizenship behavior into two broader categories, for example prosocial safety behavior (affiliative behaviors) and proactive safety behavior (change-oriented behaviors; Curcuruto et al., 2015), or safety citizenship behavior oriented towards individuals versus the organization (Laurent et al., 2020). Recently, Beus and Taylor (2018) argued for adding *unsafe behavior* to the list of safety behavior categories. These authors distinguish between *intentional* unsafe behaviors, which are "behaviors that are knowingly performed despite an awareness that they could compromise workplace safety" (p. 405) and *unintentional* unsafe behaviors, which are "behaviors that are engaged in without an explicit knowledge or awareness that they could compromise safety" (p. 405).

Safety behaviors have a small to moderate but consistent relationship with safety outcomes (e.g., Clarke, 2010, 2013). While traditionally much research attention was devoted to safety outcomes, nowadays the focus is more on safety

behaviors (Beus, 2020; Griffin & Hu, 2013). One reason for this is that safety outcomes are influenced by many aspects that are beyond control, such as weather conditions in ATC incidents. Moreover, safety events are rare (Zohar, 2000). Consequently, safety behavior can be more accurately predicted than safety consequences (Christian et al., 2009; Lofquist, 2010). Focusing on safety behavior instead of outcomes also makes it possible to take action before actual accidents or incidents happen (Beus, 2020). Indeed, while safety outcomes are *lagging* indicators of workplace safety "because they only reflect the absence of safety *after* damage has already occurred" (Beus et al., 2016, p. 354), safety behaviors are more *leading* indicators, preceding the occurrence of accidents and incidents (Beus et al., 2016).

Safety in Air Traffic Control

In ATC, too, earlier approaches to safety focused mainly on accidents and incidents (Lofquist, 2010; Oster et al., 2013). Within the industry, defining safety in terms of low accident- and incident-rates is referred to as "Safety I" (Hollnagel et al., 2013). However, failures in ATC are very rare, happening only once in 10,000 events (Hollnagel et al., 2013). Consequently, "providing a meaningful measure of safety based primarily on disastrous outcomes is a difficult task" (Lofquist, 2010, p. 1523). Thus, the attention has shifted more and more towards proactive approaches (Lofquist, 2010; Oster et al., 2013). "Safety II" refers to "ensuring that 'as many things as possible go right'" (Hollnagel et al., 2013, p. 3) and thus defines safety in terms of high safety management system flexibility and resilience. It is about daily actions and outcomes (Hollnagel et al., 2013). While in a "Safety-I"-approach, humans are seen as liability or hazard, in a "Safety-II"-approach, humans are seen as resource. In ATC and other high-reliability organizations, it is now widely acknowledged that most accidents occur due to an interplay of multiple system failures. High technology systems such as in ATC have "defenses" at the engineering (e.g., alarms), the human (e.g., ATS employees), and the procedure/administrative

level. These defenses can prevent accidents from happening, and accidents usually only happen if problems occur at several levels simultaneously (Reason, 2000).

A specific feature of the ATC context as compared to other industries is that "safety" in ATC is about *operational* safety, thus ensuring safe operational services and the surrounding's safety (Fruhen et al., 2013; Schwarz & Kallus, 2015). As such, safety behavior in ATC is an important part of operations and performance (Coetzee & Henning, 2019; Griffin et al., 2000). In contrast, "safety" is about occupational safety in many other industries, which is about the health and safety of the employees themselves (Fruhen et al., 2013; Schwarz & Kallus, 2015). Safety behavior in these industries (e.g., manufacturing) is often thought of as being opposed to productivity (Veltri et al., 2013). Another specific feature of the ATC context is that "the civil aviation industry relies more heavily on human interaction than most machine-bureaucratic organizations, and is highly influenced by human variation" (Lofquist, 2010, p. 1523).

Aviation and ATC are already very safe (Barnett, 2020; Oster et al., 2013). Indeed, "aviation is now the safest mode of commercial transportation" (Oster et al., 2013, p. 148). Even in case of accidents, the cause is rarely exclusively related to ATC. An analysis of commercial flight accidents with at least one passenger fatality showed that ATC could be ascribed to be the cause of these accidents in only between 0 and 4% of the cases (depending on the region and type of aircraft; Oster et al., 2013). Yet notwithstanding these high safety standards, the civil air navigation services organization (CANSO) foresees challenges for aviation and ANSPs:

> The coming years will present many challenges for aviation in general and for ANSPs in particular. These challenges will include increased traffic demands, prevalence of unmanned aircraft, environmental issues and security considerations. ANSP management must address these challenges while

> maintaining (and, wherever possible, improving on) current safety levels. To accomplish this, ANSP management must continually try to improve the ways they identify risks and manage safety. (CANSO, 2018, p. 5)

Until the COVID-19 crisis, European flight movements were increasing and expected to grow on average 1.8% annually between 2019 and 2025 (EUROCONTROL, 2019a). Even though the amount of flight movements decreased tremendously due to COVID-19, the amount of flight movements might be at the 2019 traffic level by 2024 and continue to grow afterwards (EUROCONTROL, 2020). This growth increases the difficulty of managing air traffic congestions on the ground (at airports) and in the air. Possibly relatedly, the amount of runway incursions, being defined as "the incorrect presence of an aircraft, vehicle, or person on an area designated for take-offs or landings" (Oster et al., 2013, p. 162), has increased (Oster et al., 2013). Of all runway incursions, 16% are caused by ATC operational errors (Rodriguez & Cusick, 2012, in Oster et al., 2013) and generally the majority of ATC operational errors include human error (Isaac et al., 2002). Thus, current and future developments may challenge the present high safety standards of ATC. Moreover, even though they are very rare, accidents do happen, and every incident or accident that can be avoided potentially saves a tremendous number of lives. This dissertation does not aim to signal a need to make ATC safer, but wishes to contribute to ways to ensure ATC safety remains high.

Many efforts are already taken to ensure air traffic safety. Indeed, "safety is the aviation industry's number one priority" (CANSO, 2018, p. 2). For example, all ANSPs have a Safety Management System (SMS), as prescribed by the International Civil Aviation Organization (ICAO). It includes (1) having clearly defined safety policies, accountabilities, and objectives, (2) managing safety risks by identifying hazards and risks and taking corrective actions, (3) monitoring, assessing, and improving the wanted and achieved safety level, and (4) safety promotion via

training, education, and safety communication (International Civil Aviation Organization, 2012). Even though the implementation of a SMS is a key contribution to improve operational aviation safety, organizations with an SMS in place may still experience safety deficiencies (Lee, 2019). Addressing supervisors' and other influences on employees' safety behavior, as well as optimizing supervisor support, may complement a SMS.

Safety Antecedents

Early research and practice concerning workplace safety antecedents focused on work design, workers' fatigue, and monotony. Recent work focusses more on the organizational context and mainly safety climate, leaders, and colleagues (Hofmann et al., 2017). Several reviews and meta-analyses of workplace safety and safety behavior and their antecedents exist (Beus et al., 2016; Burke & Signal, 2010; Christian et al., 2009; Cornelissen et al., 2017; Dodoo & Al-Samarraie, 2019; Fan et al., 2020; Grote, 2019; Hofmann et al., 2017). Workplace safety antecedents exist at the individual level (i.e., personality traits, abilities, and attitudes), at the group and organizational level (e.g., leadership, colleagues, safety climate/culture, policies, and practices), at the job level (job characteristics such as job demands), at the industry level (e.g., industry regulations and union roles), and at the national or regional level (e.g., national culture; Beus et al., 2016; Burke & Signal, 2010; Fan et al., 2020). Additional meta-analyses and reviews evidenced the impact of specific antecedents of safety behavior and/or outcomes, namely personality factors (Beus et al., 2015; Clarke & Robertson, 2005), safety climate (Beus et al., 2010; Clarke, 2006, 2010; Leitão & Greiner, 2016), leadership (Clarke, 2013; Donovan et al., 2016; Muchiri et al., 2019; Pilbeam et al., 2016), perceived support for safety and organizational commitment (Liu et al., 2020), job demands and job resources (Nahrgang et al., 2011), hindrance and challenge stressors (Clarke, 2012), safety training (Burke et al., 2011), and national culture (Keiser, 2017).

The influence of the mentioned (distal) antecedents has been explained by referring to more proximal antecedents that mediate between distal antecedents and safety behavior and outcomes (Beus et al., 2016). Most often, individuals' motivation to enact safety behavior (i.e., safety motivation), knowledge on how to behave safely (i.e., safety knowledge), and skills to behave safely (i.e., safety skills) are mentioned as proximal antecedents. These "determinants of safety performance" (p. 349) have been proposed by Griffin and Neal (2000) based on performance theory (Campbell, 1990; Campbell et al., 1993). According to this theory, job performance consists of different performance components, which are a function of motivation, knowledge, and skills (Campbell, 1990; Campbell et al., 1993). Correspondingly, safety behavior is a performance component, determined by a combination of the skills, knowledge, and motivation necessary for enacting it (i.e., safety motivation, safety knowledge, and safety skills).

Besides safety motivation, knowledge, and skills, scholars have raised burnout and engagement as proximal safety antecedents. That line of research applies the job demands-resources model (Demerouti et al., 2001; Schaufeli & Bakker, 2004) to safety (Nahrgang et al., 2011). Job demands, such as exposure to risks and hazards, are expected to lead to an increase in unsafe behavior and negative safety outcomes via an increase in burnout and a decrease in engagement. On the other hand, job resources, such as autonomy and constructive leadership, are expected to lead to a decrease in unsafe behavior and negative safety outcomes via a decrease in burnout and an increase in engagement. A meta-analysis by Nahrgang et al. (2011) investigated the expected relationships, and generally found support for them.

A third proximal safety antecedent that has been raised is behavior-outcome expectancy. More specifically, the idea is that contextual factors inform employees about consequences of their behavior, thus affecting their behavior. This rationale

forms the basis of much safety climate research. *Safety climate* refers to employees' individual or shared perceptions of the importance that is given to safety in their company or work group (Clarke, 2006; Griffin & Neal, 2000; Zohar, 1980). The assumption is that safety climate informs employees about (in)appropriate behaviors and their consequences. The resulting behavior-outcome expectations shape employees' behaviors, such that employees in a strong safety climate enact more safety behavior (Zohar, 1980).

The previously mentioned antecedents and antecedent mechanisms focus on factors that influence safety (behavior) in a general fashion, but do not discuss fluctuations of safety behavior based on different circumstances. Only very recently, Beus and Taylor (2018) discussed situational factors that impact within-person processes as additional antecedents of safety behavior. They proposed a "within-person process model of safety-related behavior" (p. 7), which suggests that the choice between a safety-focused and a non-safety-focused goal is influenced by three aspects. First, the relationship-proximity with the target, meaning the level of closeness with the person whose safety is possibly affected (e.g., self, community members). Second, characteristics of the safety behavior, specifically the likelihood that the safety behavior will lead to the desired outcome and the expenditure of resources required for behaving safely. Third, characteristics of the associated threat, meaning how severe and immediate the threat is and what the likelihood for its occurrence is. The goal choice, in turn, determines whether or not the individual behaves safely. For this model, Beus and Taylor (2018) drew on expectancy theory (Vroom, 1964). This theory proposes that whether an individual chooses a certain goal and its subsequent goal-related behavior is a function of three factors: valence, expectancy, and instrumentality. First, valence is the outcome desirability, or one's affective orientation towards the outcome. Second, expectancy is the extent to which one expects a certain behavior or effort to be related to a certain outcome or

performance. Third, instrumentality can be defined as extent to which one expects the outcome or performance to lead to an(other) outcome (Vroom, 1964).

In summary, a wide variety of antecedents of safety (behavior) have been studied, and several mechanisms have been proposed to explain the relationship between antecedents and safety (behavior). Recently, situational factors have also been suggested as playing an important role in individuals' safety behavior. One of the safety antecedents that has received considerable empirical support for its relationship with safety (behavior) is leadership. As leadership is one of the main elements of this dissertation, in the next section an introduction to leadership is given.

Leadership

Before elaborating on the empirical evidence concerning the relationship between leadership and safety, this section first gives a general introduction and overview of the concept *leadership*.

Leadership Definition and Research

Northouse (2019) makes the observation that "scholars and practitioners have attempted to define leadership for more than a century without universal consensus" (p. 33). Despite the difficulty, it is important to define leadership to advance conceptual clarity. One way to approach this is to consider aspects that often feature in the various definitions of leadership, indicating their importance to the concept. Following this approach, leadership can be defined as "a process whereby an individual influences a group of individuals to achieve a common goal" (Northouse, 2019, p. 43). As such, leadership is not restricted to individuals in formal leadership positions (i.e., assigned leadership), but also includes individuals who informally take up leadership roles (i.e., emergent leadership; Northouse, 2019). This dissertation focuses on those who are in formal leadership positions, as they have a particularly high chance of influencing employees' behavior. Formal leaders are

especially important as they often serve as role models for employees, often are in a position to reward or punish employees, and make decisions that otherwise impact employees (Kelloway & Barling, 2010). Leadership is a broad concept and "there appear to be many theories that address different aspects of leadership but little cohesion among the theories that help us understand how they all tie together" (Graen & Uhl-Bien, 1995, p. 220). Leadership research includes approaches that focus on traits and skills of leaders, leadership behavior and styles, and relations between leaders and employees (Northouse, 2019). Due to this breadth, presenting an exhaustive overview on the topic of leadership would be beyond the scope of this dissertation. Therefore, this section is limited to a discussion of leadership styles and two other relevant leadership aspects (i.e., leader-member exchange and trust(worthiness)), which reflect the leadership focus of this dissertation. Specifically, this dissertation focuses on leaders' behavior, leadership styles, dyadic relationships between leaders and employees, and trustworthiness of leaders.

Leadership Styles

A *leadership style* consists of "the pattern of attitudes that leaders hold and behaviors they exhibit" (Anderson & Sun, 2017, p. 76). The most widely studied leadership styles are transactional and transformational leadership. These two styles were first introduced by Burns (1978), and further developed and established by Bass (1985) and others (e.g., Avolio, 1999). *Transactional leadership* focuses on proper exchanges between leaders and employees. It entails clarifying expectations, giving rewards and punishments based on the extent to which employees meet expectations (i.e., contingent reward), and taking corrective actions (i.e., management by exception – active), but also waiting for errors to happen before stepping in as a leader (i.e., management by exception – passive; Judge & Piccolo, 2004). *Transformational leadership*, on the other hand, goes beyond the mere transaction and offers "a purpose that transcends short-term goals and focuses on

higher order intrinsic needs" (Judge & Piccolo, 2004, p. 755). It entails behaving in admirable, charismatic ways (i.e., idealized influence), inspiring and articulating a vision (i.e., inspirational motivation), stimulating employees intellectually (i.e., intellectual stimulation), and attending and reacting to employees' needs in function of the larger collective goals (i.e., individualized consideration; Judge & Piccolo, 2004). However, the transformational-transactional leadership framework has been criticized. For example, Antonakis et al. (2016) point out that the conceptualization of transformational leadership is ambiguous, has no theoretical basis, and is based on its outcomes. Moreover, different authors contend that the effects of transformational leadership on organization and employee outcomes are often overestimated (Antonakis et al., 2016; Antonakis & House, 2014). Finally, they argue other leadership functions and behaviors exist beyond transformational and transactional leadership (e.g., Antonakis & House, 2014). To capture these missing aspects, especially in the last two decades, novel leadership styles emerged (for a review on leadership styles, see for example Anderson & Sun, 2017). Some examples of more frequently studied styles are authentic leadership (Avolio, Walumbwa, et al., 2009, p. 423; Luthans & Avolio, 2003), servant leadership (Greenleaf, 1977; Liden et al., 2008), and ethical leadership (Brown et al., 2005). *Authentic leadership* can be defined as "pattern of transparent and ethical leader behavior that encourages openness in sharing information needed to make decisions while accepting followers' inputs" (Avolio, Walumbwa, et al., 2009, p. 423). *Servant leadership* is characterized by integrity, serving employees and the broader community, and a focus on employees' needs and the realization of their potential (Liden et al., 2008). *Ethical leadership* reflects "the demonstration of normatively appropriate conduct through personal actions and interpersonal relationships, and the promotion of such conduct to followers through two-way communication, reinforcement, and decision-making" (Brown et al., 2005, p. 120).

Hoch et al. (2018) compared the predictive value of these three styles vis-a-vis transformational leadership concerning employee and organization outcomes in a meta-analysis. They found that, while the added value of ethical and authentic leadership is low, "servant leadership … showed more promise as a stand-alone leadership approach that is capable of helping leadership researchers and practitioners better explain a wide range of outcomes" (Hoch et al., 2018, p. 502). Specifically, servant leadership is more predictive of positive employee behavior (i.e., organizational citizenship behavior) and attitudes (i.e., engagement, job satisfaction, and organizational commitment) than transformational leadership (Hoch et al., 2018).

Other Leadership Aspects

Besides leaders' characteristics (e.g., traits, behavior, styles), leadership is also about followers (i.e., the employees that are being "led"; e.g., the effect of their expectations, attitudes, and behavior on the effectiveness of leadership styles) as well as the relationship between leaders and followers (Graen & Uhl-Bien, 1995). The most prevalent relationship-based approach is *leader-member exchange* (LMX). LMX focusses on the dyadic working relationship between a leader and an employee and describes the quality of its social exchange in terms of mutual trust, respect, and obligation (Graen & Uhl-Bien, 1995).Moreover, *trust* provides fertile ground to nurture high quality relations with followers. While trust is "the intention to accept vulnerability to a trustee based on positive expectations of his or her actions" (Colquitt et al., 2007, p. 909; "trustee" refers to the trust(worthiness) referent, i.e. the leader), trustworthiness describes "the ability, benevolence, and integrity of a trustee" (Colquitt et al., 2007, p. 909), based on both cognitive considerations as well as affective acknowledgements. Both aspects are highly related (Colquitt et al., 2007; Mayer and Gavin, 2005) and trustworthiness acts as a key antecedent of trust (Jones and Shah, 2016; Mayer et al., 1995). Trust and trustworthiness are central

concepts in the leadership literature as is illustrated by an almost 20 year old statement: “the significance of trust in leadership has been recognized by researchers for at least four decades” (Dirks & Ferrin, 2002, p. 611).

Leadership Outcomes

A large body of empirical evidence shows that leadership plays an important role for group and organization outcomes (e.g., organizational performance) as well as for employee behavior (e.g., employee performance, turnover), attitudes (e.g., commitment, motivation, satisfaction), and health or wellbeing (see e.g. Dirks & Ferrin, 2002 for trust in leadership; Gerstner & Day, 1997 for LMX; Hoch et al., 2018 for servant, ethical, authentic, and transformational leadership; Judge & Piccolo, 2004 for transformational and transactional leadership). In summary, leadership is a broad concept, researched in various forms, among which numerous leadership styles, LMX, and leaders’ trustworthiness. In all these forms, leadership plays an important role for group, organization, and employee outcomes. Before looking at the role leadership plays for employees’ safety behavior, the leadership system in ATC is shortly introduced.

Leadership in Air Traffic Control

The ATC context is unique in its leadership roles and system at the supervisor level. Due to the specifics of each unit (tower units versus air traffic control centers, amount and type of air traffic present etc.), each unit has different supervisor roles and leadership systems. While in some units supervisors are mainly charged with operational tasks (e.g., decision-making concerning runway-use), in other units supervisors have more coordinating and organizing tasks (e.g., coordinating activities with the airport). Moreover some units and ANSPs employ a system of rotating leadership. In this case, the person in charge changes every shift, meaning supervisors work as supervisors during some shifts and as ATS employees during others. This also implies that while in one shift, person A is in the supervisor role

and person B in an ATS employees' role, in another shift their roles can be reversed. This system entails unique challenges and is, therefore, important to take into account.

Leadership and Safety Behavior

"Due to its strong influence on followers and organizational processes, leadership is claimed to play a critical role not only in relating to goal achievement and efficiency, but also with regard to workplace safety" (Nielsen et al., 2016, p. 142). More and more evidence supports the validity of this statement.

Reviews and Meta-Analyses

During the last decade, three systematic reviews and one meta-analysis focused on the relationship between leadership and safety. First, Lekka and Healey (2012) reviewed the academic literature as well as policy research reports and incident documentations for effective leadership behaviors for safety. Their research was not published in a scientific journal but funded by and conducted for the Health and Safety Executive, a UK government agency. The authors reviewed 40 studies and analyzed 16 major accidents. One of their findings was that "transformational and transactional theories of leadership have received considerable empirical support suggesting that they can be appropriate for the effective management of safety" (Lekka & Healey, 2012, p. iii). Moreover, the authors found that passive leadership, referring to leaders who ignore the responsibilities of leadership or only intervene after errors happened (Kelloway et al., 2006), is *negatively* related to safety behaviors and safety climate. Additionally, trust in management and high quality LMX, especially between supervisors and employees, are important for safety as they relate to safety climate, safety motivation, accident involvement, and injuries (trust) and safety communication, safety citizenship behavior, and safety related events (LMX). Lekka and Healey (2012) also discussed specific safety-related attitudes and behaviors of leaders important for various safety aspects, namely management

commitment to safety, leader support for safety, enforcement of safety policies and procedures, safety communication, and active involvement in safety.Secondly, Clarke (2013) conducted a meta-analysis focusing on transformational leadership (under which she also categorized LMX and empowering leadership) and active transactional leadership. The author included 32 relevant studies measuring these leadership styles in relation to safety. The meta-analysis found support for a model in which both leadership styles have a distinct and positive relationship with safety participation and compliance, partly mediated by the perceived safety climate. Moreover, the safety behaviors are subsequently related to occupational injuries. The effect sizes for the relationships between the leadership styles and safety behaviors were moderately strong (ρ ranging between .31 and .44), and while safety compliance was more strongly related to active transactional leadership (vs. transformational leadership), safety participation was more strongly related to transformational leadership.

Donovan et al. (2016) reviewed the evidence concerning leadership and safety outcomes more broadly and incorporated 35 relevant studies. They found that transformational, transactional, authentic, and empowering leadership as well as LMX have been researched in relation to safety. All these leadership aspects related to various safety aspects (e.g., safety behavior, climate, knowledge, accidents). The authors also concluded that most studies investigated transformational and transactional leadership, and that most research was conducted in the manufacturing and construction industries.

Lastly, Pilbeam et al. (2016) reviewed 25 studies discussing the relationship between leadership and safety behavior. Similar to Donovan et al. (2016), they reported a research focus on transformational and transactional leadership, but also on LMX. Pilbeam et al. (2016) found that these three leadership aspects are related to safety compliance, safety participation, and safety citizenship behavior. Pilbeam

et al. (2016) also revealed a minority of studies that investigated more concrete leader practices. For example, Zohar and Luria (2003) and Luria et al. (2008) found that supervisors' safety-related feedback increases employees' safety compliance and safety climate. Generally, Pilbeam et al. (2016) pointed out that most research had been conducted in the manufacturing, engineering, and process industries, mainly in hierarchical organizations from the private sector.

Next to these four studies, several other meta-analyses and reviews have been conducted with leadership as one of several antecedents of safety behavior (Beus et al., 2016; Burke & Signal, 2010; Christian et al., 2009; Hofmann et al., 2017; Liu et al., 2020; Nahrgang et al., 2011). These studies provide additional evidence for the relationship between leadership and safety. Notably, Liu et al. (2020) conduced a meta-analysis concerning the relationships between, on the one hand, perceived supervisor support for safety, perceived co-worker support for safety, and organizational commitment, and on the other hand safety task behavior and safety citizenship behavior. While 15 studies examined the relationship between perceived supervisor support for safety and safety task behavior, eleven studies investigated the relationship between that leadership aspect and safety citizenship behavior. Perceived supervisor support for safety was moderately strongly related to both safety behaviors (β = 0.31 and 0.32, respectively). Type of industry and level of regional economic development acted as moderators, such that the combination of a) perceived supervisor support for safety, b) perceived co-worker support for safety, and c) commitment had a stronger relationship with safety behaviors in general (vs. high-risk) environments and in developed (vs. developing) regions (Liu et al., 2020).

Finally, in their unique 100-year review of the safety literature, Hofmann et al. (2017) emphasized that solid evidence supported an important role for leaders, particularly supervisors, for ensuring workplace safety:

> The role of the immediate supervisor has been identified to be a key influence on safety outcomes. It is in the "micro-decisions" made by these frontline managers and the degree to which day-in and day-out they reinforce and signal the importance of safety where the "rubber meets the road" so to speak with respect to safety. (p. 382)

Summarizing the evidence from the meta-analyses and reviews, we can conclude that there is substantial evidence concerning the relationship between various leadership aspects and safety. Especially transformational and transactional leadership have received considerable research attention and their role as safety (behavior) antecedent is well established. However, most research has been conducted in the manufacturing, engineering, construction, and processing industries. Table 1.1 presents an overview of all researched leadership aspects with their safety correlates. The previously mentioned meta-analyses and reviews are indicated with an asterisk.

Additional Evidence

Besides the aspects mentioned in these meta-analyses and reviews, several other leadership aspects have been researched in relation to safety. For example, two doctoral dissertations investigated servant leadership in the safety context. First, Krebs (2005) found that servant leadership is negatively related to near misses and accidents in a pharmaceutical organization directly, and mediated by employees' actively caring for safety. Second, Henderson (2013) revealed that servant leadership is positively related to employees' safety voice in industrial and construction work contexts. Similarly, two additional studies investigated ethical leadership. Chughtai (2015) focused on Pakistani hospital doctors and found that ethical leadership was related to employees' safety participation and compliance, via job autonomy and self-efficacy. On the other hand, Enwereuzor et al. (2020) found

in a sample of Nigerian hospital nurses that ethical leadership is related to employees' safety compliance, via trust in the leader.

Moreover, another study showed that perceived *leadership involvement* relates to offshore workers' safety compliance (Dahl & Olsen, 2013). Leadership involvement in this study refers to "supervisors who are close to the front end of the work operations and have a cooperative and participative relationship with their subordinates and the work that they perform" (Dahl & Olsen, 2013, p. 19). Another relevant concept is leaders' *injunctive safety norms*, referring to leaders' approval and expectations concerning safety behavior. Leaders' injunctive safety norms are an antecedent of Canadian young workers' risk taking (Pek et al., 2017). A related concept to injunctive safety norms is *psychological contract of safety*, which can be defined as "the beliefs of individuals about reciprocal safety obligations inferred from implicit or explicit promises" (Walker & Hutton, 2006, p. 433). Psychological contract of safety has been found to be positively related to flight attendants' creative safety performance ("willingness and ability to generate novel ideas regarding safety"; Vatankhah, 2021, p. 1) and negatively to their safety violations (intentionally behaving unsafely), via flight attendants safety motivation (Vatankhah, 2021). Finally, Credo et al. (2010) focused on *management safety concern*, which reflects "employee perceptions of the extent to which management makes an effort to promote and explain safety procedures and safety behaviors" (p. 329). The authors found that management safety concern is positively related to employee safety involvement, a combination of their safety knowledge and safety behaviors, in a US drilling company.

A minority of authors focused on more concrete, safety-specific behaviors of leaders. For example, Casey et al. (2019) developed bundles of safety leadership practices for supervisors and co-workers related to employees' safety compliance and safety proactivity. The bundles were differentiated based on self-regulatory

mechanisms and were termed “leverage” (e.g., safety performance recognition), “energize” (e.g., providing safety-related growth opportunities), “adapt” (e.g., reflection on past safety performance), and “defend” (e.g., carefully monitoring safety compliance). The authors also specified in which situation which leadership practices are most effective. Moreover, Griffin and Hu (2013) found that leaders’ safety inspiring, safety learning, and safety monitoring behaviors influence safety participation and safety compliance in different ways, and interact with each other in that influencing process. Specifically, they found that safety inspiring leadership behavior relates positively to employees’ safety participation, but not safety compliance, while safety monitoring relates positively to safety compliance. Safety monitoring also relates positively to safety participation if the leader promotes safety learning, whereas it relates negatively to safety participation if the leader does *not* promote safety learning.

In summary, a broad range of leadership aspects have been researched in relation to safety behaviors, ranging from general leadership styles to more concrete safety-related leadership behaviors. An overview of evidence is presented in Table 1.1.

Table 1.1

Overview of Empirical Evidence Concerning Leadership and Safety

Leadership aspect	Employee outcomes	Sources
Transformational leadership	Safety climate (+), safety culture (+), safety participation (+), safety citizenship behavior (+), safety compliance (+), safety performance (+), safety knowledge (+), safety involvement (+), safety commitment (+), occupational injuries (−)	Clarke (2013)*, Donovan et al. (2016)*, Lekka and Healey (2012)*, Pilbeam et al. (2016)*
Transactional leadership	Safety climate (+), safety participation (+), safety citizenship behavior (+), safety compliance (+), safety awareness (+), accident rates (−), occupational injuries (−)	Clarke (2013)*, Donovan et al. (2016)*, Lekka and Healey (2012)*, Pilbeam et al. (2016)*
Passive leadership	Safety climate (−), safety consciousness (−), safety-related events and injuries (+)	Lekka and Healey (2012)*
Authentic leadership	Safety climate (+), safety participation (+), safety compliance (+), risk perception (−)	Donovan et al. (2016)*
Empowering leadership	Safety climate (+), safety culture (+), safety participation (+), safety compliance (+), risky behavior (−), accidents (−)	Donovan et al. (2016)*
Servant leadership	Actively caring for safety (+), safety voice (+), near misses (−), accidents (−)	Henderson (2013), Krebs (2005)
Ethical leadership	Safety participation (+), safety compliance (+)	Chughtai (2015), Enwereuzor et al. (2020)
Trust in management/leader	Safety climate (+), safety motivation (+), accident involvement (−), injuries (−)	Lekka and Healey (2012)*

Table 1.1

Overview of Empirical Evidence Concerning Leadership and Safety

Leadership aspect	Employee outcomes	Sources
LMX	Safety climate (+), safety participation (+), safety citizenship behavior (+), safety communication (+), safety commitment (+), incident reporting (?), safety-related events (−), accidents (−)	Donovan et al. (2016)*, Lekka and Healey (2012)*, Pilbeam et al. (2016)*
Management commitment to safety	Risk-taking (−), violations (−), incidents (−), learning from safety events (+)	Lekka and Healey (2012)*
Management safety concern	Safety involvement	Credo et al. (2010)
Leader support for safety	Safety citizenship behavior (+), safety communication (+), safety task behavior (+), safe work practices (+), injuries (−)	Lekka and Healey (2012)*, Liu et al. (2020)*
Enforcement of safety policies and procedures	Incident under-reporting (−), injuries (−)	Lekka and Healey (2012)*
Safety communication	Safety behaviors (+), risk-taking (−), work-related pain (−)	Lekka and Healey (2012)*
Leadership involvement (in safety & generally)	Safety climate (+), safety accountability & responsibility (+), safety compliance (+)	Lekka and Healey (2012)*, Dahl and Olsen (2013)
Safety-related feedback	Safety climate (+), safety compliance (+)	Luria et al. (2008), Zohar and Luria (2003)
Leaders' injunctive safety norms	Risk-taking (−)	Pek et al. (2017)
Psychological contract of safety	Creative safety performance (+), safety violations (-)	Vatankhah (2021)

Table 1.1

Overview of Empirical Evidence Concerning Leadership and Safety

Leadership aspect	Employee outcomes	Sources
Bundles of various safety leadership practices (e.g., safety performance recognition)	Safety proactivity (+), safety compliance (+)	Casey et al. (2019)
Safety inspiring behavior	Safety participation (+)	Griffin and Hu (2013)
Safety monitoring behavior	Safety compliance (+), safety participation (+ in case of high safety learning promotion, − in case of low safety learning promotion)	Griffin and Hu (2013)

Note. (+) refers to a positive association and (−) refers to a negative association; (?) refers to a relationship for which it was not clear whether the relationship was positive or negative. An asterisk as superscript (*) indicates reviews and meta-analyses.

General vs. Safety-Specific Leadership

In the safety literature, general and safety-specific leadership aspects are often distinguished. For example, some authors refer to transformational leadership in general using traditional scales from the leadership literature, whereas other authors refer to safety-specific transformational leadership and tailor the concept and the measurement to the safety context. Both approaches have their advantages. On the one hand, general leadership approaches take into account that leaders are typically also engaged in non-safety related tasks, and they avoid the confounding effect between safety-specific leadership aspects and safety-related outcome variables, such as safety climate or safety behavior (Inness et al., 2010). On the other hand, preliminary evidence suggests incremental associations of safety-specific leadership aspects with safety-related independent variables beyond general leadership (Mullen & Kelloway, 2009).

Different Hierarchy Levels

The safety impact of leadership has been investigated at different hierarchy levels, such as the supervisor, management, and CEO level, and leadership at each of these levels is important for safety (Donovan et al., 2018; Flin & Yule, 2004). Optimal leadership behaviors and styles for safety differ, depending on the leadership level (Donovan et al., 2018; Flin & Yule, 2004). For example, Flin and Yule (2004) argue that optimal leadership at the supervisory level focusses on operational aspects and includes monitoring and reinforcing employees' safety behaviors and being supportive of safety initiatives. At the middle management level, aspects such as safety involvement and emphasis on the importance of safety over productivity are crucial. At the senior management or CEO level, visible safety commitment is the most important aspect (Flin & Yule, 2004). Management commitment to safety is often used as a safety climate dimension and is a robust predictor of occupational injuries (Beus et al., 2010). It is expressed by aspects such as giving high priority to safety in meetings, putting emphasis on safety-training, relegating executive authority to safety officials, and personal involvement of management in regular safety activities (Zohar, 1980). Not only is (different) leadership at different levels important for safety, the effects of leadership at different levels interact, too. For example, safety priority assigned by higher superiors moderates the relationship between direct supervisors' transformational and transactional leadership and safety climate (Zohar, 2002b). Moreover, behaviors and decisions of leaders are influenced by behaviors and decisions at other work system levels, such as the staff and the company leaders (Donovan et al., 2018; Donovan et al., 2017).

Impact of the Context

The impact of leadership on employees' safety behavior also differs depending on the context. For example, Willis et al. (2017) revealed that

"management-by-exception-active", which is a dimension of transactional leadership, is related to more safety participation of employees in environments where safety is perceived as being very critical (i.e., high accident likelihood). On the other hand, this leadership dimension is related to *less* safety participation in environments where safety is perceived to be not so critical. Mirza and Isha (2017) developed a framework summarizing safety-effective leadership styles depending on four organizational-context factors: culture (adaptive vs. authoritative), structure (high vs. moderate safety-sensitive and higher vs. lower hierarchical level), processes (high vs. low level of standardization), and people (diverse vs. uniform workforce). These contextual factors influence to a large extent which leadership styles are most effective.

Moreover, Hoffmeister et al. (2014) investigated the relative importance of the individual dimensions of transformational and transactional leadership for safety behavior (and safety climate and safety outcomes) of construction worker apprentices and journeymen. Overall, idealized influence in terms of its two sub-facets "idealized attributes" (attributions that are made concerning the leader) and "idealized behaviors" (the leader's actual behaviour; Bass & Riggio, 2006) are the most influential for safety behavior and safety climate perceptions. However, the most important leadership dimensions differed depending on the kind of safety behavior (i.e., safety compliance vs. safety participation) and the employee status (i.e., apprentices vs. journeymen). While apprentices' safety compliance was only significantly influenced by idealized behavior, journeymen safety compliance was influenced by idealized attributes, idealized behavior, and contingent reward (in order of importance). Moreover, apprentices safety participation was impacted by idealized behaviors, idealized attributes, inspirational motivation, and contingent reward, while no separate leadership dimension had an influence on journeymen's safety participation (although leadership as a whole was relevant; Hoffmeister et al.,

2014). Thus, which leadership behaviors are most important depends on whose and which safety behavior one wants to increase. Hoffmeister et al. (2014) concluded that "the relationship between leadership and safety is complex" (p. 77) and "specific characteristics of leaders impact specific aspects of safety at work" (p. 77). Safety-effective leaders also act dynamically and adapt their leadership style and behaviors to the situational needs and the decisions they are taking (Donovan et al., 2018).

Nature of the Relationship Between Leadership and Safety

A final note relates to the nature of the relationship between leadership and safety. Until recently, scholars assumed and investigated only linear relationships between leadership and safety. Yet, Katz-Navon et al. (2020) challenged this approach by arguing and delivering first empirical evidence for a curvilinear relationship between leadership and safety. For example, they found that a medium level of transformational leadership is worse in terms of employees' safety behavior and safety motivation than a low or a high level, as employees perceived medium transformational leadership as unclear and inconsistent. The authors did not find evidence for a curvilinear relationship between transactional leadership dimensions and safety outcomes. Moreover, high transformational leadership was still better for safety outcomes than low transformational leadership. We can conclude from these findings that it is very important for leaders (with a transformational leadership style) to act consistently. Moreover, the general assumption of linear relationships between leadership and safety does not always hold. The importance of consistency is in line with research on procedural justice that found that consistency is an important criterion to evaluate the fairness of processes. Consistency in this context refers to consistent applications of rules and procedures or consistent supervisor decisions across people, time, and situations (Blader & Tyler, 2016; Colquitt, 2001; Leventhal, 1980). Procedural justice perceptions in turn are related to, among

others, positive leader evaluations, rule compliance, and helping behaviors (Colquitt, 2001). (Colquitt, 2001; Sargeant et al., 2017)

Mechanisms

Scholars have suggested multiple mechanisms to explain the relationship between leadership and safety. The most often suggested and examined mechanism is that constructive leaderships improves safety climate, which, in turn, increases employees' safety behavior (Clarke, 2013; Lekka & Healey, 2012). As Clarke (2013) puts it: "Climate perceptions represent the individual's cognitive interpretations of the organizational context, bridging the effects of this wider context on individual attitudes and behaviour" (p. 27). Zohar and Luria (2003) further argue that an improved safety climate is indicative for a behavior-outcome expectancy mechanism. According to their reasoning, safety-related feedback from supervisors increases the expectation that safety behavior is valued and rewarded, reflected in an improved safety climate, which in turn increases safety compliance.

Another suggested mechanism consists of the safety motivation, knowledge, and skills trifecta, proposed by Griffin and Neal (2000) based on performance theory (Campbell, 1990; Campbell et al., 1993). While the mediating roles of safety motivation and safety knowledge have been investigated and found (Christian et al., 2009; Lekka & Healey, 2012; Neal & Griffin, 2004), the mediating role of safety skills has not yet been investigated.

Expanding the factors of motivation, knowledge, and skills, the ability-motivation-opportunity (AMO) framework stretches the importance of opportunities in determining performance (Blumberg & Pringle, 1982). This framework argues that performance is an interactive function of an individual's ability (or capacity) under which skills and knowledge are categorized, motivation (or willingness to perform), and opportunity. "Opportunity" refers to environmental factors beyond employees' control, such as supplies, working conditions, or leader behavior (Blumberg &

Pringle, 1982). According to that reasoning, leadership, as one opportunity-factor, would not (only) affect employees' motivation, skills, and knowledge, but mainly interact with these factors to mutually influence employees' (safety) behavior. Although the AMO framework has not yet been applied to the relationship between leadership and employees' safety behavior, Dahlin et al. (2018) applied the AMO framework to explain learning from failures and errors in organizational contexts, a topic with high safety-relevance. According to their review, leadership plays a role in individuals' motivation and ability: "leadership style can motivate learning; however, it also reflects the group's ability to learn and a leader's ability to enhance group learning" (Dahlin et al., 2018, p. 261). Leadership as an opportunity factor in safety research has yet to be investigated.

The relationship between active leadership behaviors (safety-specific transformational leadership and two dimensions of transactional leadership: contingent-reward and management by exception - active) and employees' safety motivation is further mediated by employees' safety attitudes and norms (Sawhney & Cigularov, 2019). Specifically, active leadership behaviors instill positive attitudes towards safety in employees and establish norms for safety behaviors. Attitudes and norms, in turn, are two independent determinants of motivation, in accordance with theory of planned behavior (Ajzen, 1991).

Discussing the motivational path more in depth, self-regulation states (motivational conditions) have also been argued to act as mechanism to explain the relationship between leadership and safety (Casey et al., 2019; Kark et al., 2015). The literature involved often distinguishes between prevention and promotion self-regulatory foci, based on regulatory focus theory (Higgins, 1997). A prevention self-regulatory focus refers to a proclivity to prevent loss and harm, and a concern for security and the fulfilment of duties and obligations. In contrast, a promotion self-regulatory focus refers to a proclivity to strive for positive outcomes and ideals, and

a concern for gain, growth, and advancement (Higgins, 1997). Situational self-regulatory foci may be influenced by the environment, for example by a leader, and, in turn, may influence followers' behavior. In the safety domain, for example, Kark et al. (2015) revealed that transformational leadership leads to safety initiative (a sub-aspect of safety participation) via a promotion self-regulatory focus, while active transactional leadership is related to safety compliance via a prevention self-regulatory focus. Also referring to self-regulation mechanisms, Griffin and Hu (2013) argued that leadership behaviors instill different safety-related goals in employees, which, in turn, direct employees' safety behavior.

Another motivational approach in this context distinguishes between different types of motivation that correspond with different experiences and outcomes, based on self-determination theory (Ryan & Deci, 2000). While intrinsic motivation "refers to doing an activity for the inherent satisfaction of the activity itself" (Ryan & Deci, 2000, p. 71), extrinsic motivation "refers to the performance of an activity in order to attain some separable outcome" (Ryan & Deci, 2000, p. 71). In that line of research, leadership relates to different safety behaviors by increasing different types of motivation. For example, Conchie (2013) found that safety-specific transformational leadership relates to employees' whistle-blowing and safety voice via nurturing employees' intrinsic motivation (only when trust in the leader is high), while safety-specific transformational leadership relates to safety compliance via identified regulation, a form of extrinsic motivation. Moreover, in their review, Pilbeam et al. (2016) argued that while transactional leadership increases employees' extrinsic motivation, transformational leadership increases employees' intrinsic motivation, and both increase employees' safety behavior.

Similar to the general leadership literature and drawing on social exchange theory (Blau, 1964; Gouldner, 1960), a social exchange mechanism is also often used to explain the relationship between leadership and employees' safety behavior

(Mirza & Isha, 2017). The central tenet of this theory is the norm of reciprocity; that is, the assumption that a treatment of one person is reciprocated by that person with a relational and/or behavioral response of the same valence (Gouldner, 1960). In that vein, a positive treatment by a leader is expected to encourage employees reciprocating with positive behavior, being safety behavior in high-risk environments (Mirza & Isha, 2017). Applying social exchange theory, Hofmann and Morgeson (1999) found that LMX is related to accidents via stimulating an open communication concerning safety and consequently increasing employees' safety commitment.

Trust in the leader, a leadership aspect itself, has also been put forward as mediating the relationship between leadership styles and safety behavior, drawing on social exchange mechanisms. For example, in a UK oil refinery context, Conchie et al. (2012) found that safety-specific transformational leadership is related to safety voice via affect-based trust toward leaders and subsequently *disclosure (trust) intention*, which is "an individual's willingness to disclose sensitive information to another, where such information may cause harm to the individual if used with negative intent" (p. 107). The effect of disclosure (trust) intention was moderated by reliance trust intention, such that disclosure intention only acted as mediator if employees intended to rely on their leader. Moreover, Enwereuzor et al. (2020) revealed that ethical leadership is related to employees' safety compliance via trust in the leader in Nigerian healthcare organizations. Finally, perceived organizational support has been suggested as mechanism. Specifically, Credo et al. (2010) found that management safety concern was related to employee safety involvement via perceived organizational support. Management safety concern was related to perceived organizational support, both directly as well as indirectly via LMX and perceived organizational ethics. In these studies, the norm of reciprocity has been applied to argue that due to leadership's influence on open safety

communication, trust, and organizational support perceptions, employees feel obliged to reciprocate with favorable behavior, which is safety behavior in safety contexts (Conchie et al., 2012; Credo et al., 2010; Enwereuzor et al., 2020).

Furthermore, albeit only to a limited extent, role modeling has been brought forward as mechanism, a concept central to social learning theory (Bandura, 1977, 1986). One of the theory's premises is that role modeling (i.e., vicarious learning) plays a crucial role in individuals learning of behaviors. This means that people observe others and may subsequently use the gained information regarding behavior rules to guide their own behavior. Furthermore, social learning theory proposes that people with high status, power, and competence are particularly effective role models (Bandura, 1977), making leaders more prone to be modeled. In the safety literature, Maierhofer et al. (2000) linked managers' safety-related values and safety compliance to employees' safety-related values and safety compliance on the basis of role modeling processes. Murphy et al. (2012), too, emphasized the importance of social learning to elicit safety behavior. Finally, the concept of "safety-specific transformational leadership" refers to role modeling, as its definition inherits to "stand out as role models for their staff by working in a safe way themselves" (Dahl & Olsen, 2013, p. 18).

A separate body of literature draws on the job demands-resources model. In that reasoning, constructive leadership, as a job resource, decreases employees' unsafe behavior and negative safety outcomes by decreasing employees' burnout and increasing their engagement (Nahrgang et al., 2011).

Eid et al. (2012) suggested psychological capital, a positive psychological development state characterized by self-efficacy, optimism, hope, and resilience (Luthans et al., 2007), as a mechanism (besides safety climate) linking authentic leadership and safety behaviors and outcomes. According to their reasoning, authentic leadership increases employees' psychological capital and strengthens the

safety climate; in turn, psychological capital and safety climate interact to facilitate and encourage safety behavior (Eid et al., 2012).

Furthermore, Yang et al. (2020) suggested belongingness need satisfaction as mediator between leadership and safety behavior, subsequently leading to safety performance. The authors refer to the group engagement model (Tyler & Blader, 2000), which argues that the treatment of a supervisor is regarded as expressing group norms and values by employees and therefore influences their psychological bonding with the work group; that is, their sense of belonging. Sense of belonging, in turn, influences group-oriented behaviors: the higher the sense of belonging, the more group-oriented behaviors individuals enact. In the safety context, group-oriented behaviors are reflected by safety behavior. The authors tested this mechanism with abusive supervision, referring to "subordinates' perceptions of the extent to which supervisors engage in *the sustained display of hostile verbal and nonverbal behaviors, excluding physical contact*" (Tepper, 2000, p. 178). As expected, Yang et al. (2020) found that abusive supervision was negatively related to employees' safety behavior via a weakened belongingness need satisfaction. Furthermore, the relationship was moderated by social standing uncertainty, such that uncertainty increased the negative influence of abusive supervision on belongingness need satisfaction. Yang et al. (2020) also examined the role of social exchange and burnout as alternative mechanisms. While they found burnout to be a significant mediator as well, social exchange was *not* significant as additional mediator besides burnout and sense of belonging. Leadership scholars have also explained positive effects of transformational leadership by referring to effects on group belongingness feelings. Specifically, transformational leadership behaviors, such as articulating a vision and taking personal risks to reach that vision, are thought to increase group belongingness among employees and shifting employees' focus from self- to collective interest (De Cremer & van Knippenberg, 2002).

Other mechanisms that have been suggested are commitment, open communication, collaborative learning, and role clarity. Specifically, Parker et al. (2001) found evidence for organizational commitment as mediator between supportive supervision and employees' safety compliance. Moreover, empowering leadership is related to safety participation via increased collaborative learning, which is directly impacted by empowering leadership and indirectly via promoting dialogue and open communication (Martínez-Córcoles et al., 2012). On the other hand, empowering leadership relates to safety compliance via clarifying employees' roles (Martínez-Córcoles et al., 2014).

Finally, according to Pilbeam et al. (2019), employees' awareness is a possible mechanism of the relationship between interventions developed by leaders and safety outcomes. Following that reasoning, employees who are more aware and attentive to their workplace circumstances are more likely to prevent accidents or injuries. Leaders may increase this awareness by encouraging employees to pay more attention to their work environment (Pilbeam et al., 2019).

Summing all of this up, a variety of mechanisms have been suggested to explain the relationship between leadership and safety (behavior). The proposed mechanisms can be divided into four categories, namely (1) safety climate as mechanism, (2) (safety) motivation, ability and/or opportunity as mechanism(s), (3) leadership-specific mechanisms, and (4) general (work and organizational psychology) mechanisms. Table 1.2 presents an overview of the categories with all mechanisms, the applied leadership aspects, and the corresponding theories and frameworks. The wide variety of suggested mechanisms and theories involved as well as the lack of integration hints on the fragmented nature of the safety literature.

Table 1.2

Overview of Mechanisms Suggested in the Literature to Explain the Relationship Between Leadership and Safety

Category	Mechanisms[a]	Applied leadership aspects	(Exemplary) sources	Corresponding theories / frameworks
Safety climate	Safety climate (and behavior outcome expectancy)	Transformational and transactional leadership	e.g., Clarke (2013), Lekka and Healey (2012)	Safety climate theory (Zohar, 2010) and organizational climate theory (Zohar, 2011, as cited in Beus et al., 2016)
(Safety) motivation, ability, and/or opportunity	Safety motivation, knowledge, skills	General leadership aspects (e.g., LMX, transformational leadership)	e.g., Christian et al. (2009), Neal and Griffin (2004)	Performance theory (Campbell, 1990; Campbell et al., 1993)
	Ability, motivation, opportunity	/	See Dahlin et al. (2018)	Ability-motivation-opportunity (AMO) framework (Blumberg & Pringle, 1982)
	Safety attitudes and norms → safety motivation	Safety-specific transformational leadership, contingent-reward, management by exception - active	Sawhney and Cigularov (2019)	Theory of planned behavior (Ajzen, 1991)
	Situational self-regulatory foci	Transformational and transactional leadership	Casey et al. (2019), Kark et al. (2015)	Regulatory focus theory

Table 1.2

Overview of Mechanisms Suggested in the Literature to Explain the Relationship Between Leadership and Safety

Category	Mechanisms[a]	Applied leadership aspects	(Exemplary) sources	Corresponding theories / frameworks
				(Higgins, 1997)
	Extrinsic and intrinsic motivation	Safety-specific and general transformational leadership, transactional leadership	Conchie (2013), Pilbeam et al. (2016)	Self-determination theory (Ryan & Deci, 2000)
Leadership-specific mechanisms	Reciprocation	Transformational leadership, transactional leadership, LMX	Hofmann and Morgeson (1999); Mirza and Isha (2017)	Social exchange theory (Blau, 1964; Gouldner, 1960)
	Open safety communication → safety commitment	LMX	Dahl and Olsen (2013); Hofmann and Morgeson (1999); Maierhofer et al. (2000); Murphy et al. (2012)	Social learning theory (Bandura, 1977, 1986)

Table 1.2

Overview of Mechanisms Suggested in the Literature to Explain the Relationship Between Leadership and Safety

Category	Mechanisms[a]	Applied leadership aspects	(Exemplary) sources	Corresponding theories / frameworks
	Trust in the leader	Safety-specific transformational leadership, ethical leadership	Conchie et al. (2012), Enwereuzor et al. (2020)	
	Perceived organizational support	Management safety concern, LMX	Credo et al. (2010)	
	Role modeling	Safety-specific transformational leadership, managers' safety-related values and safety compliance	Dahl and Olsen (2013) Maierhofer et al. (2000), Murphy et al. (2012)	Social learning theory (Bandura, 1977, 1986)
General mechanisms	Burnout and engagement	Constructive leadership	Nahrgang et al. (2011)	Job demands-resources model (Demerouti et al., 2001; Schaufeli & Bakker, 2004)
	Psychological capital	Authentic leadership	Eid et al. (2012)	/
	Belongingness need satisfaction	Abusive supervision	Yang et al. (2020)	Group engagement model (Tyler & Blader, 2000)
	Organizational commitment	Supportive supervision	Parker et al. (2001)	/

Table 1.2

Overview of Mechanisms Suggested in the Literature to Explain the Relationship Between Leadership and Safety

Category	Mechanisms[a]	Applied leadership aspects	(Exemplary) sources	Corresponding theories / frameworks
	(Dialogue promotion & open communication →) collaborative learning	Empowering leadership	Martínez-Córcoles et al. (2012)	/
	Role clarity	Empowering leadership	Martínez-Córcoles et al. (2014)	Organizational role theory (Katz & Kahn, 1966)
	Awareness	Encouraging employees to pay attention	Pilbeam et al. (2019)	/

Note. [a] different aspects summed up with a comma refer to mechanisms that act parallel, while aspects with an arrow (→) in between aspects refer to a sequence as mechanism

Leadership and Safety in Air Traffic Control

The current evidence highlights that the relationship between leadership and safety is gaining increasing attention in the literature. Scholars have also acknowledged the importance of investigating the role of leadership and the most effective leadership style(s) in ATC, due to the important role leadership may play and the risk that is involved in ATC (Arvidsson et al., 2007). Moreover, interpersonal problems with supervisors have been identified as major stressor by Canadian and New Zealand ATCOs (Shouksmith & Burrough, 1988). Hence, leadership may potentially lead to a safety risk, but it can also encourage ATC safety. Yet, evidence from the ATC sector concerning the relationship and ATC safety is scarce and fragmented. Below, an overview of relevant studies is given.

Some authors investigated prevalent leadership styles and leadership behavior in ATS. For example, Arvidsson et al. (2007) looked at situational leadership of team managers in a Swedish ANSP, who have a coordinating function, executing tasks related to human resource management (HRM), training and development, and work scheduling. The authors compared situations characterized by success, situations characterized by hardship, situations including a leader in relation to the group he/she leads, and situations including a leader in relation to an individual employee. In success-characterized or group situations, most team managers behaved highly relationship- and lowly task-oriented. In situations characterized by hardship or individual relations, most team managers used high task- and high relationship-oriented behavior (Arvidsson et al., 2007). However, situational leadership has not received the necessary support to reliably interpret these findings. Two doctoral dissertations investigated the prevalence of transformational, transactional, and laissez-faire (avoiding leadership responsibilities) leadership among US ATC managers and revealed transformational leadership as the most predominant style (Krear-Klostermeier, 2012; McLelland, 2016). Another study in the US investigated leadership of ATS supervisors depending on the situation (normal vs. emergency/complex) and staffing (fully certified ATCO vs. trainee at work; Melton et al., 2014). The authors compared behaviors that were observed by chief ATCOs with behaviors that were rated as most favorably by subject matter experts. The congruence between the two was high and the ratings indicated that, while there were differences according to the situation (normal vs. emergency/complex) and staffing (fully certified ATCO vs. trainee at work), the overall most preferred style by ATCOs and experts alike was coaching and supporting as opposed to directing and delegating (Melton et al., 2014).

Other studies looked at leadership as antecedent for safety or other (related) outcomes. To our knowledge, only one study has tested the link between leadership

and ATS employees' safety behavior. Jiang et al. (2017) found that supervisors' LMX leads to employees' safety citizenship behavior, both directly and indirectly via affective trust in coworkers (partly mediated by cognitive trust in coworkers). It must be stated, though, that while 46.8% of the (Chinese) sample were ATCOs, 53.2% were airline maintenance staff.

Öge et al. (2018) investigated paternalistic leadership of supervisors in a Turkish ANSP. Paternalistic leadership refers to a leadership style characterized by asserting authority and control, while at the same being concerned with employees' well-being and displaying moral integrity (Pellegrini & Scandura, 2008). Öge et al. (2018) revealed that supervisors' paternalistic leadership style was positively related to ATS employees' engagement. While the authors did not investigate a relationship with employees' safety behavior, according to applications of the job demands-resources model to safety, engagement would further translate to safety behavior (Nahrgang et al., 2011).

In a qualitative study with a focus on teamwork in ATC, Read and Charles (2018) also discussed (Royal Air Force) ATCOs' perceptions of supervisors. ATCOs perceived that their supervisors had an important role in preventing accidents and incidents. According to them, supervisors need to know the capability, personality, and "external issues" (unspecified; Read & Charles, 2018, p. 43) of the ATS employees in their unit, as well as have a good overview of the traffic situation. Moreover instead of micromanaging, supervisors need to "manage effectively, providing support to the right people at the right times" (Read & Charles, 2018, p. 43). All of these aspects seem to indicate the importance of supervisors' situation awareness, the "perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley, 2016, p. 36). Read and Charles (2018) concluded:

> The quality of supervision was highlighted in this research as an area that can provide significant value or cause significant detriment to controllers. A review of the role of a Supervisor and criteria for suitability would enable the position to be optimised. (p. 44)

Coetzee and Henning (2019) examined the congruence between: a) how ATCOs perceived team managers' qualities (in terms of e.g., conscientiousness, fairness, leadership) and b) how team managers thought to be perceived, in a South African ANSP. They found that the larger the discrepancy between the perceptions, the lower the team morale. Team morale can be defined as "the collective attitudes and shared commitments among members with regard to their team tasks" (He, 2012, p. 64). Coetzee and Henning (2019) suggested but did not test the importance of team morale for safety. As such, leaders' self- and social awareness may be important for ATC safety.

Lofquist et al. (2011) investigated leadership commitment to safety without reference to a specific leadership level at a European ANSP during an organizational change process. They surveyed ATCOs and found that perceived leadership commitment to safety was related to safety perceptions, both directly and indirectly via a change in attitudes towards change. Although not investigated, safety perceptions were expected to relate positively to ATCOs' safety behavior and consequently safety performance (Lofquist et al., 2011). Moreover, commitment to safety from supervisors and management are important indicators of ATS employees' perceived safety culture (Stroeve et al., 2011), which in turn relates positively to ATS employees' safety behavior (Schwarz & Kallus, 2015).

Ek and Arvidsson (2012) developed a tool to maintain and proactively improve safety in a Swedish ANSP by identifying and monitoring organizational factors that are important for safety. By interviewing ATCOs, supervisors, and managers who had formerly been ATCOs, while also taking into account literature

findings and earlier ATC research, the authors determined which organizational aspects are relevant for safety. One of the resulting eight aspects was leadership. Specifically, supervisors' willingness to listen to work-related problems, supervisors' initiative to solve identified problems, and managements' listening and problem-solving were identified as being important (Ek & Arvidsson, 2012). One reason for the importance of ATC managers' problem-solving is that it demonstrates their safety commitment (Fruhen et al., 2014a), which is important for safety as indicated above. Specifically, Fruhen et al. (2014a) found that ATC senior managers' understanding of problems, considered information sources for understanding problems, and idea generation to solve problems are related to their demonstration of safety commitment. Moreover, the social competence of perceiving others and understanding their intentions is important for ATC senior manager's demonstration of safety commitment (Fruhen et al., 2014a).

In another study, Fruhen et al. (2014b) introduced the term "safety intelligence", which captures senior managers' understanding of safety issues and knowledge relevant to safety-related policy making, and is therefore related to their ability to develop and enact policies that have a positive effect on safety. The authors found that the following six attributes are relevant for senior managers' safety intelligence: (1) social competence (e.g., communication and listening skills), (2) safety knowledge, (3) motivation, (4) problem-solving skills, (5) personality characterized by openness, conscientiousness, and agreeableness, and (6) transformational, transactional, and authentic leadership skills (Fruhen et al., 2014b).

Fruhen et al. (2013) found that "just culture" is a dominant theme for senior managers in ANSPs when thinking about safety culture. Just culture reflects "an atmosphere of trust where people are encouraged and even rewarded to provide essential safety-related information, but also in which it is clear where the line

between acceptable and unacceptable behavior is drawn" (Fruhen et al., 2013, p. 328). It is an industry-specific term and very similar to "psychological safety", which is "a shared belief held by members of a team that the team is safe for interpersonal risk taking" (Edmondson, 1999, p. 350). According to ATC senior managers, a strong just culture and safety culture are supported by management's creation of mutual trust between them and employees, sincerity concerning safety, time allocation to safety to convey their safety prioritization, exemplary behavior, and clarification of the line between acceptable and unacceptable behavior (Fruhen et al., 2013).

ATC accident and incident investigations sometimes also mention the role of leadership. For example, the investigation of a major aviation accident (mid-air collision) with 71 fatalities near Überlingen (Germany) in 2002 brought forward the important role of management in improving safety and contributing to the prevention of aircraft accidents. Specifically, the investigators stated that management needs to be committed towards safety, establish safety as high priority and common goal, and give feedback and continuous reinforcement down the organization to establish a strong safety culture and develop dedication and accountability among staff (BFU, 2004). Moreover, the absence of a supervisor was a contributing factor to the accident. The report states that "efficient supervision of the system by the DL [supervisor] would ensure the ATCO was afforded the appropriate resources at the 'sharp end' to best manage the air traffic situation" (BFU, 2004, p. 83). Thus, ATC supervisors have an important role in providing needed resources to ATS staff and consequently preventing accidents.

Summarizing the empirical evidence, transformational leadership seems to be prevailing among ATC managers (in the US). Moreover, evidence suggests that supervisors are important for ATC safety and it is crucial that they adapt their behaviors to the situation and maturity level of the ATS employees they are working

with. Leadership aspects that seem to be important for ATC safety are supervisors' LMX, paternalistic leadership, situation awareness, and appropriate resource provision, team managers' self- and social awareness, and more generally leadership commitment to safety, listening, problem-solving, and social skills. Moreover, (senior) managers have an impact on ATC safety, via shaping perceptions of just culture and other safety culture aspects, evoking dedication and accountability, and developing and enacting safety-related policies. Several attributes, among which leadership characteristics, are important for these managerial influence pathways. The evidence concerning the relationship between leadership and safety in ATC is summarized in Table 1.3.

Table 1.3

Overview of Empirical Evidence Concerning Leadership and Safety in Air Traffic Control

Leadership aspects	Correlate/Outcome	Leadership level	Source
LMX	Safety citizenship behavior	Supervisors	Jiang et al. (2017)
Paternalistic leadership	Engagement	Supervisors	Öge et al. (2018)
Situation awareness, appropriate resource provision	Accident and incident prevention	Supervisors	BFU (2004), Read and Charles (2018)
Self- and social awareness	Team morale	Team managers	Coetzee and Henning (2019)
Leadership commitment to safety	Safety perceptions, safety culture	Supervisors & management	BFU (2004), Fruhen et al. (2014a), Stroeve et al. (2011)

Table 1.3

Overview of Empirical Evidence Concerning Leadership and Safety in Air Traffic Control

Leadership aspects	Correlate/Outcome	Leadership level	Source
Listening, problem-solving skills, perceiving others	Safety	Supervisors & management	Ek and Arvidsson (2012), Lofquist et al. (2011),
Social competence, safety knowledge, motivation, problem-solving skills, personality characterized by openness, conscientiousness, and agreeableness, transformational, transactional, and authentic leadership skills	Safety intelligence	Senior management	Fruhen et al. (2014b)
Mutual trust creation, sincerity concerning safety, time allocation to safety, safety prioritization, exemplary behavior, clarification of the line between acceptable and unacceptable behavior, feedback and reinforcement	Just culture, safety culture, dedication and accountability	Management	BFU (2004), Fruhen et al. (2013)

Objectives and Overview of the Dissertation

Considering the literature reviewed above and practical relevance for the ATC industry, several research aims, questions, and topics can be formulated. These constitute the basis of the three empirical studies that have been conducted and, as such, structure the current dissertation. Overall, this dissertation aims to increase our knowledge on leadership and safety by looking at their relationship in ATC, investigating the link between leadership and employees' cognitive task

performance, and examining the role of situational factors in individuals' safety behavior.

First Aim and Study 1

The first aim of this dissertation is to investigate whether the relationship between leadership and safety established in other fields of application holds for the ATC context. As indicated above, research on the relationship between leadership and safety in ATC is scarce. However, as we have also seen, the context plays a significant role concerning the relationship between leadership and safety (Mirza & Isha, 2017; Willis et al., 2017). As Mirza and Isha (2017) put it: "Despite the growing body of literature on the salience of leadership for workplace safety, questions have been raised concerning leadership effectiveness mostly because extent literature remains largely oblivious to the context in which the leader-follower relationship operates" (p. 167).

Study 1, drawing on existing knowledge and theories, develops a rationale for expecting that leadership is important for ATS employees' safety behavior. More specifically, ATS supervisors' servant leadership, trustworthiness, LMX, and safety support are included. Servant leadership has, to date, only scarcely been studied in relation to safety (Mirza & Isha, 2017). Although evidence is restricted to two doctoral dissertations as mentioned above, it is promising. Trustworthiness and LMX are two other leadership aspects that have been found to be important for safety. Finally, the application of supervisor support for safety acknowledges the importance of safety-specific leadership aspects besides the use of general leadership aspects.

By investigating how ATS employees could behave as safely as possible, study 1 takes a "Safety II"-approach and focuses on ATS employees as *the* resource to increase air traffic safety. In that way, the study responds to the need of looking beyond mere accidents and incidents, and takes a more proactive approach.

Moreover, it follows Andersen and Bove (2000), who stated that maintaining high safety standards in ATC may critically depend on ATS employees' behavior. While acknowledging that ATC safety does not solely depend on ATS employees' behavior, employees are one part of the system and may prevent incidents by forming a "system defense" or "safeguard" (Reason, 2000).

Second Aim and Study 2

The second aim of this dissertation is to shed more light on the relationship between leadership and cognitive task performance, namely attention, working memory, and problem-solving performances. Cognitive performance is especially important for employee performance when employees need to think quickly and adaptively, when new job demands occur and time pressure is high (Chan et al., 2018), which is true for many jobs, including that of ATS employees. In the ATC domain, the importance of cognitive performance is well documented (Shorrock & Kirwan, 2002). ATS employees need attention, working memory, and problem-solving in their dynamic cognition-oriented job to perform well (Hilburn, 2004; Isaac et al., 2002), which in an ATC context mainly means behaving safely. Cognitive resources have also more directly been shown to be important for safety behavior and outcomes. For example, poor visual and auditory attention performance and failure in information processing have been linked to errors and accidents (Lawton & Parker, 1998). In aviation, too, attention and memory-related factors have been identified as risk-factors that are associated with accidents and serious incidents (EASA, 2020). Moreover, cognitive failure, defined as "a cognitively based error that occurs during the performance of a task that a person is normally successful in executing" (Martin, 1983, p. 97) is related to safety behavior and outcomes (Wallace & Chen, 2005).

In the leadership literature, scholars often argue that leaders should provide resources to employees. In the safety literature, too, it is argued that effective

leadership behaviors for safety involve to "provide the necessary resources" (Lekka & Healey, 2012, p. iii). However, research concerning the stimulation of employees' resources by leaders is mostly restricted to emotional- or wellbeing-related resources. Moreover, the leadership literature more generally mainly focusses on motivational outcomes of employees. Thus, research examining the relationship between leadership and employees' cognitive performance, indicating cognitive resources, is limited. Yet, such research is needed to extend our theoretical understanding of resource-based processes, and test the applicability of the conservation of resources (COR) theory (Hobfoll, 1989) to cognitive resources. This theory is a well-established theory of human motivation that explains individuals' gain, loss, and (re)investment of resources, which are "entities that either are centrally valued in their own right (e.g., self-esteem, close attachments, health, and inner peace) or act as a means to obtain centrally valued ends (e.g., money, social support, and credit)" (Hobfoll, 2002, p. 302). COR theory is often applied to explain leadership's impact on employees, yet not concerning cognitive resources. Particularly from a practical point of view, it is relevant to investigate whether leadership may enhance cognitive performance due to the relations of cognitive performance with job performance and safety behavior. This is what the second study does. More specifically, it focuses on the more traditional leadership styles of transformational and transactional leadership and examines their relationship with employees' attention, working memory, and problem-solving performance.

Third Aim and Study 3

The third aim of this dissertation is to gain insight into the relationship between *situational factors* on the one hand and safety compliance and safety performance on the other. Although safety and safety behaviors are often studied as if they would be stable characteristics merely dependent on safety motivation, knowledge, and skills, in fact "safety is a highly dynamic condition that varies as a

function of factors such as organizational priorities, workplace conditions, and individual choices" (Beus, 2020, p. 304). Beus and Taylor (2018) discussed situational factors that would affect variations in safety behavior. Yet, that discussion remained rather theoretical and empirical evidence is needed (Beus, 2020). Thus, study 3 investigates the influence of two situational factors, that are cognitive load and perceived responsibility for safety on individuals' safety compliance and performance. This study draws on the bounded ethicality literature, which states that situational and psychological factors restrict ethical decision-making and ethical behavior (e.g., De Cremer & Vandekerckhove, 2017; Tenbrunsel et al., 2010; Zhang et al., 2014). In line with this, the term "bounded safety" is introduced in study 3 to refer to situational factors that may restrict safety-related decision-making and behavior. Moreover, study 3 examines the role of individuals' personality as moderator between on the one hand cognitive load and perceived responsibility and on the other hand safety compliance and performance. That way, possible situation-person interactions that have been found in the ethics literature (Gino et al., 2011; Treviño et al., 2006), but have not yet been investigated in the safety literature, are taken into account. Situational factors are relevant to investigate as, besides contextual factors such as leadership, concrete, situation-dependent challenges may transform a generally safe workplace into an unsafe one (Beus, 2020). Indeed, as Yang et al. (2020) say:

> Although promoting safety is a collective process, major failures of safety can often be attributed to the omissions of individuals. Even one seemingly minor omission has the potential to cause disastrous consequences for human life and the viability of the organization, particularly when the workplace and customers intersect in hazardous contexts. (p. 11)

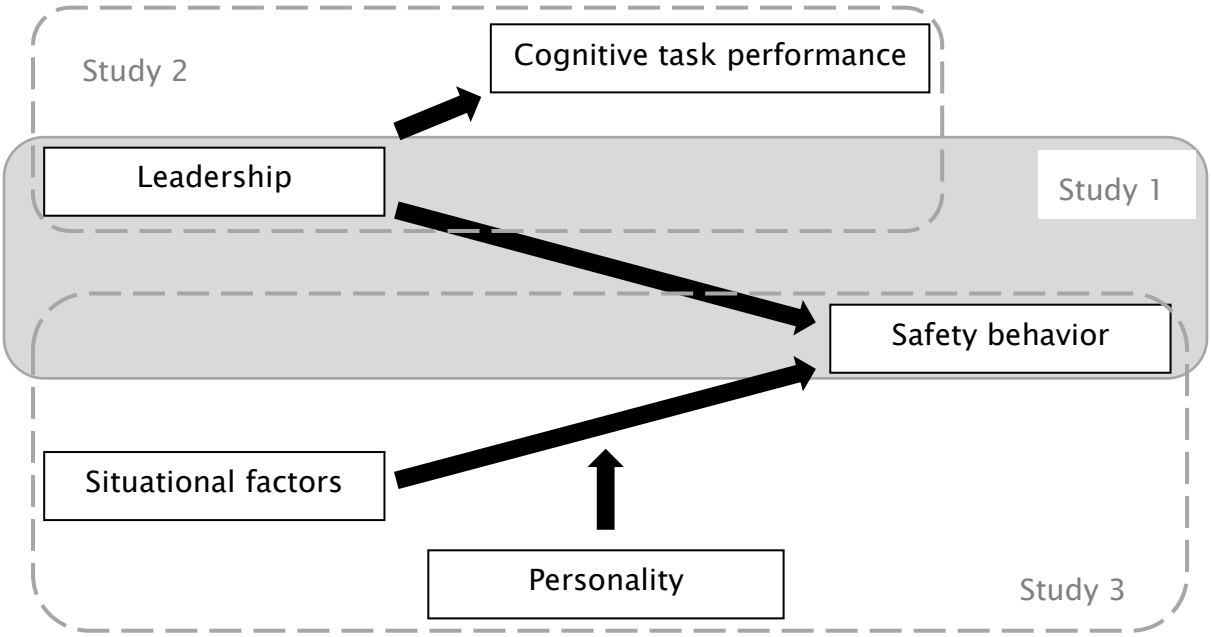
Therefore, the impact of situational factors on employees' safety compliance and performance may be detrimental and needs to be examined and taken into account.

Overview

Figure 1.1 presents a schematic overview of the different subjects of the three empirical studies. While study 1 (chapter 2) investigates the link between leadership and employees' safety behavior, study 2 (chapter 3) focuses on the relationship between leadership and employees' cognitive task performance. Study 3 (chapter 4) investigates the link between situational factors and individuals' safety behavior, and the moderation of this relationship by individuals' personality. Finally, chapter 5 summarizes and integrates the findings of the three studies and discusses theoretical and practical implications as well as strengths, limitations, and future research suggestions.

Figure 1.1

Schematic Overview of the Dissertation



Chapter 2:

The Role of Leadership in Air Traffic Safety Employees' Safety Behavior[2]

[2] This chapter has been published: Schopf, A. K., Stouten, J., & Schaufeli, W. B. (2021). The role of leadership in air traffic safety employees' safety behavior. *Safety Science, 135*, 105118. https://doi.org/https://doi.org/10.1016/j.ssci.2020.105118

Abstract

Safety behavior is the most critical task for air traffic controllers and other air traffic safety (ATS) employees. The literature shows that one of the main antecedents for ensuring safety is leadership. Yet, the understanding of leadership within air traffic control (ATC) is very limited. Drawing on both social learning theory and social exchange theory, the current research proposes and investigates the relationship between leadership aspects and ATS employees' safety behaviors.

Data were obtained from 49 ATS employees of a European air navigation service provider (ANSP), who rated their current supervisor's servant leadership, trustworthiness, leader-member exchange, and support for safety as well as their own safety compliance and safety citizenship behavior during one to five consecutive shifts. The results of hierarchical regression analyses showed, unexpectedly, a significant negative association between supervisors' trustworthiness and employees' safety citizenship behavior. None of the other hypothesized relationships was significant. These findings as well as additional findings from post-hoc interviews and open comment fields suggest that the specific ATC context may require different processes than other industries. Additionally, trustworthiness may be related to lower safety citizenship behavior, possibly because ATS employees believe trustworthy supervisors take care of everything. Although a closer additional examination is warranted, ANSPs might want to take into account difficulties associated with supervisors' trustworthiness.

Keywords: safety behavior, servant leadership, trustworthiness, leader-member exchange, supervisor support for safety, air traffic control

Introduction

Employees' safety behavior, which is behavior benefitting colleagues', clients', the public's, and the environment's safety and health (Burke et al., 2002), consistently relates to safety outcomes, such as occupational injuries and accidents (e.g., Clarke, 2010, 2013). Safety behavior is a crucial factor for organizations as it not only links to physical harm, but safety outcomes also have negative organizational, social, and economic consequences (Burke et al., 2002; Zohar, 2002b).

A large body of literature exists on antecedents of safety behaviors and outcomes, including several meta-analyses (e.g., Christian et al., 2009; Clarke, 2010; Nahrgang et al., 2011) and reviews (e.g., Beus et al., 2016; Donovan et al., 2016; Hofmann et al., 2017). These show that leadership is one of the main antecedents for ensuring safety. Different leadership aspects are important for safety behavior, such as constructive leadership styles (Christian et al., 2009; Donovan et al., 2016; Hofmann et al., 2017; Nahrgang et al., 2011), trust in the leader (Nahrgang et al., 2011), leader-member exchange (LMX; Christian et al., 2009; Donovan et al., 2016; Hofmann et al., 2017; Nahrgang et al., 2011), and supervisor support for safety (Nahrgang et al., 2011). While leadership at different hierarchical levels seems to be important for safety, particularly the immediate supervisor plays a key role: "It is in the 'micro-decisions' made by these frontline managers and the degree to which day-in and day-out they reinforce and signal the importance of safety where the 'rubber meets the road' so to speak with respect to safety" (Hofmann et al., 2017, p. 382).

Despite the evidence concerning the relations between leadership and employees' safety behavior, the role of leadership in air traffic control (ATC) has rarely been explored. ATC aims to "promote the safe, orderly, and expeditious flow of aircraft in flight or operating in the maneuvering area of an airport" (Ek &

Arvidsson, 2012, p. 12). In this context, "safety is the most important driver of operations" (Coetzee & Henning, 2019, p. 1). Currently, flight movements in Europe are increasing, and expected to grow further with an average annual increase of 2.0% between 2019 and 2025 (EUROCONTROL, 2019b). As such, maintenance of high safety levels is increasingly difficult and crucially depends on air traffic controllers (ATCOs)' behavior (Andersen & Bove, 2000).

It is important to examine whether the specific conditions of ATC require similar processes as other industries. As the context is important for particular outcomes, scholars have recommended to focus on the specific context when conducting research (Bamberger, 2008; Galvin, 2014; Tsui, 2006). Moreover, Mirza and Isha (2017) stated that "questions have been raised concerning leadership effectiveness mostly because extent literature remains largely oblivious to the context in which the leader-follower relationship operates". For example, industries differ in types of job demands and risks inherent to the work, as well as concerning the person at risk being others or oneself. Consequently, the job demands and resources contributing the most to safety outcomes also differ between industries (Nahrgang et al., 2011).

The ATC context is especially unique from other settings when it comes to safety behavior and leadership. First, safety behavior in ATC is about operational safety, namely providing safe operational services and ensuring the safety of the surrounding. This differs from what is investigated in other safety research, namely occupational safety, which relates to the physical integrity of the workers themselves (Fruhen et al., 2013; Schwarz & Kallus, 2015). While in traditionally researched industries such as manufacturing, scholars typically discuss a trade-off between safety and operations (Veltri et al., 2013), in ATC, safety behavior is an important *part* of operations (Coetzee & Henning, 2019).[3] Besides orderliness and

[3] We thank an anonymous reviewer for bringing up this issue.

efficiency, safety is one of the three main performance outcomes in ATC (Griffin et al., 2000). In the literature, task performance is based on routine and adaptive performance (Pulakos et al., 2000). Hence, for ATC, safety behavior collapses largely with both routine and adaptive performance, which would make ATC a particular context in which safety is most crucial for performing well. As such, the predictions that hold for task performance seem relevant for safety behavior in this context. This is in contrast to safety research in which performance is more distant from safety behavior, where other predicting factors may be at play.

Second, supervisors in ATC have a different role than in other high-risk industries. Besides team organization tasks, such as ensuring adequate breaks, ATC supervisors also fulfil administrative tasks, such as reporting overtime hours and illnesses of employees, and technical tasks, such as coordinating runway changes. Furthermore, in some units the supervisor role is rotating, such that alternatingly supervisors are in a supervisor role in some shifts and in an employee role in others. As such, they may be the supervisor of an employee who is their own supervisor during another shift.

Due to this specific context, the current research aims to investigate the relationship between different leadership aspects – constructive leadership, trust, LMX, and supervisor support for safety – and employees' safety behavior in ATC. In a qualitative study, Read and Charles (2018) found that "the quality of supervision […] can provide significant value or cause significant detriment to controllers". The current research investigates whether "quality of supervision" also influences air traffic safety (ATS) employees' safety behavior. It follows a similar logic as the meta-analysis of Nahrgang et al. (2011) on safety outcomes, in that the current study also examines constructive leadership, trust, LMX, and supervisor support for safety, as these factors have been shown to be important for safety in other industries. The current research investigates the relationships between each of these leadership

aspects separately and employees' safety behavior, as opposed to the approach of Nahrgang et al. (2011) of aggregating all leadership aspects into one overarching variable and investigating accidents and injuries, adverse events, and unsafe behavior as outcomes. Moreover, unlike the current study, which focusses specifically on ATC, Nahrgang et al. (2011) did not study the ATC context, but looked at the construction, health care, manufacturing/processing, and transportation industries.

The current study investigates the relationship between the above mentioned leadership aspects and ATS employees' safety behavior by means of a diary study design in a sample of ATS employees who rate their current supervisor as well as their own safety behavior on a daily basis. It draws on both social learning theory (Bandura, 1977, 1986) and social exchange theory (Blau, 1964; Gouldner, 1960) to clarify *why* constructive leadership aspects (in the form of a constructive leadership style, trustworthiness, LMX, and support for safety) relate to ATS employees' safety behavior.

Besides its value for the ATC industry, the current research also aims to contribute to the leadership and safety literature(s) by discussing a constructive leadership style that is relatively new to the safety literature, namely servant leadership. According to a recent meta-analysis (Hoch et al., 2018), this leadership style, in which employees, their needs, and the realization of their potential are of central importance (Liden et al., 2008), is more predictive of positive behavioral and attitudinal measures such as organizational citizenship behavior (OCB), employee engagement, job satisfaction, and organizational commitment than traditional leadership typologies.

In their review on the relationship between leadership styles and safety, Donovan and colleagues (2016) pointed out that our current knowledge about leadership's role in safety behavior and outcomes is "elementary at best". From a

practical point of view, we aim to show how to effectively maintain or increase ATS employees' safety behavior by focusing on supervisors' leadership. In the discussion, we also address how to support supervisors in their role of increasing and maintaining ATS employees' safety behavior.

Theory and Hypotheses

Safety Behavior

Safety behaviors may be divided into (1) *safety compliance*, referring to maintaining workplace safety by carrying out basic safety activities prescribed by the job, and (2) *safety participation*, referring to facilitating the development of a safety-supporting environment (Griffin & Neal, 2000). Examples of the former are behaving in accordance with safety rules and wearing protective equipment, whilst an example of the latter is participating in voluntary safety activities. This categorization reflects the more general distinction between task performance and contextual performance. Both task and contextual performance are distinct factors of ATS employees' performance, which contribute to ATS employees' perceived effectiveness (Griffin et al., 2000).

A further differentiation of safety behaviors is related to safety participation: *safety citizenship behavior*, the safety-specific variant of OCB (Hofmann et al., 2003). OCB can be defined as "performance that supports the social and psychological environment in which task performance takes place" (Organ, 1997, p. 95). Safety citizenship behavior refers to behavior that facilitates a safety-supportive work environment. Hofmann and colleagues (2003) distinguish between six dimensions, namely safety-related helping, voice, stewardship, whistleblowing, civic virtue (keeping informed about safety issues), and initiation of change.

We follow the distinction between safety compliance and safety citizenship behavior. Moreover, the specificity of ATC that safety behavior concerns operational safety requires adapting safety behaviors that do *not* match the ATC context. We do

this by replacing measures of these behaviors with measures of concrete operational safety behaviors. By focusing on concrete behaviors and measuring them on a daily basis, we satisfy the need for research on specific safety behaviors (Conchie, 2013; Curcuruto et al., 2015).

Leadership and Safety Behavior

Based on Nahrgang et al. (2011), we focus on (1) a constructive leadership style, which is operationalized as servant leadership, (2) trustworthiness of the supervisors, (3) LMX, and (4) supervisor support for safety.

According to social learning theory (Bandura, 1977, 1986), most behaviors are learned by role modeling (i.e., vicarious learning). This means that people observe others and may use the obtained information regarding successful behaviors to guide their own future behavior. Furthermore, social learning theory proposes that people with high status, power, and competence are more effective role models (Bandura, 1977). Thus, supervisors with favorable leadership characteristics are especially prone to serve as role models. As ATS supervisors' main task is to serve for safety, safety behavior is theorized to be the modeled behavior by ATS employees. The importance of role modeling in increasing employees' safety behavior has been highlighted by Murphy et al. (2012).

Social exchange theory's central paradigm is that the treatment of person A by person B is reciprocated by relational and/or behavioral responses of the same valence by person A (Gouldner, 1960). This is referred to as the norm of reciprocity. Favorable leaders treat employees well, which is expected to make employees reciprocating with positive behavior. This positive behavior can be hypothesized to be safety behavior in high-risk environments (Mirza & Isha, 2017), and more specifically in ATC, as reaching safety is the most important task of ATS supervisors.

Research in industries other than ATC shows that the impact of leadership on safety compliance is high, with average aggregated effect sizes of $r_c = .59$ ($\%R^2 =$

22.2) for manufacturing, .60 ($\%R^2$ = 20.4) for transportation, .62 ($\%R^2$ = 50.1) for construction and .69 ($\%R^2$ = 32.5) for health care. Similarly, leadership's impact on accidents and injuries (r_c between -.16 and -.40 and $\%R^2$ between 9.8 and 83.9) and adverse events (r_c between -.20 and -.41 and $\%R^2$ between 3.2 and 12.1) is significant (Nahrgang et al., 2011). Unfortunately, empirical data in the ATC context is missing. Even though ATS employees are trained to be very self-reliant and safety is fundamental to their attitude and job, leadership is expected to still be important for ATS employees' safety behavior. Read and Charles (2018) found that ATS employees perceive the supervisor role to be crucial to prevent unsafe events. Instead of actively guiding specific tasks, ATS supervisors are required to maintain employee support (e.g. given the high pressure ATS employees are subject to), while taking into account ATS employees' capability and personality as well as specific contextual circumstances.

Servant Leadership

"Servant leadership stresses personal integrity and serving others, including employees, customers, and communities" (Liden et al., 2008, p. 161). It entails having the skills to support employees, putting employees first, empowering them, and helping them to realize their potential. Moreover, servant leaders notice others' personal concerns, want to help the community, and behave ethically (Liden et al., 2008). While servant leadership was first introduced by Greenleaf (1977) in the 1970s, it has only recently received considerable research attention (Hoch et al., 2018; Liden, Panaccio, et al., 2014).

The leadership literature showed that servant leadership predicts variance above and beyond other leadership concepts for employee outcomes (Hoch et al., 2018; see also Liden, Panaccio, et al., 2014; Van Dierendonck, 2011) and hints on relations with the most important employee behaviors in ATC, namely, safety citizenship behavior and safety compliance. Findings that servant leadership relates

positively to employee behaviors and outcomes have been replicated in the safety literature, albeit very preliminary and warranting further investigation (Mirza & Isha, 2017). For instance, two doctoral dissertations found a positive relation between servant leadership and safety behaviors and/or outcomes (Henderson, 2013; Krebs, 2005). More specifically, Krebs (2005) found servant leadership to be negatively related to near misses and accidents in a pharmaceutical organization, with a partial mediation by employees' actively caring for safety. Likewise, Henderson (2013) found servant leadership to be positively related to subordinates' safety voice in a sample of employees working in industrial and construction work contexts.

Second, unique characteristics of servant leaders, such as empowering and helping employees to grow and succeed, are able to increase ATS employees' safety behavior. Indeed, ATS employees usually need to handle the traffic they are responsible for individually. That is, individual ATS employees have the complete picture of the traffic and supervisors are generally not required to help with task-related instructions (unless called upon). Instead, servant leaders help employees to stay focused on safety issues (e.g., by maintaining and discussing safety issues) and help them grow in their work, which allows ATS employees to perform better. Further, the overall most preferred leadership behavior by North-American ATCOs and ATC experts is coaching and supporting as supposed to directing and delegating (Melton et al., 2014). Servant leadership, as defined above, is the theoretical answer to ATS employees' personal preferences, which would therefore nurture positive outcomes as it aligns with ATS employees' prototypical leader (Epitropaki & Martin, 2005; Khorakian & Sharifirad, 2019). Moreover, while ATS employees are exposed to a high amount of work stress, potentially threatening their well-being (Tshabalala & De Beer, 2014), servant leadership actually has been argued to improve subordinates' wellbeing (Parris & Peachey, 2013). Finally, servant leaders are able to react to the changing needs of ATS employees in the dynamic

ATC context, in which "situations can change rapidly, and controllers can be faced with very difficult problems in a short space of time" (Griffin et al., 2000, p. 520).

Role modeling (Bandura, 1977, 1986) and social exchange (Blau, 1964; Gouldner, 1960) have been proposed as theoretical mechanisms for the association between servant leadership and positive work outcomes (Liden, Panaccio, et al., 2014). Servant leaders – more than other leaders – may act as role models because their pro-social behaviors and expertise make them interpersonally attractive and credible (Liden, Panaccio, et al., 2014; Liden, Wayne, et al., 2014). In the literature, modeling is regarded a main attribute of servant leadership (Russell & Stone, 2002). According to Liden et al. (2014), servant leaders' prosocial and moral identity is strongly modeled by employees. We consider this essential for safety citizenship behavior and safety compliance in high-risk environments, where enacting safety behavior is regarded as social and moral. Servant leaders appeal to employees' responsibility and accountability (Stouten & Liden, 2020), which would encourage employees' awareness to safety issues. Moreover, as employees become servant themselves, they show concern for people inside and outside the organization (Graham, 1991) and perform prosocial behavior and organizational and community citizenship behaviors (Liden, Panaccio, et al., 2014), which is expected to further enhance safety behavior.

Concerning social exchange, a servant leader treats employees well, leading employees to feel obliged to reciprocate with positive behavior (Gouldner, 1960; Liden, Panaccio, et al., 2014). This positive behavior can be hypothesized to be safety compliance and safety citizenship behavior in ATC, as servant leaders are concerned with employees' and the community's wellbeing (Liden et al., 2008), for which safety behavior in ATC is crucial. Additionally, employees' safety behavior is a performance indicator in high-risk environments, which may increase the likelihood of a good evaluation of the leader by senior management (cf., Hofmann & Morgeson,

1999). In line with this reasoning, Hofmann and Morgeson (1999) found that a social exchange mechanism increased employees' safety communication and safety commitment. Therefore, we formulate:

Hypothesis 1a. Servant leadership is positively related to ATS employees' safety compliance.

Hypothesis 1b. Servant leadership is positively related to ATS employees' safety citizenship behavior.

Trustworthiness

Perceived trustworthiness describes a person's attributional judgement of another person (i.e., trustee), based on the trustees' ability, benevolence, and integrity (Jones & Shah, 2016; Mayer et al., 1995). It is a key determinant of trust for a trustee (Jones & Shah, 2016; Mayer et al., 1995) and trustworthiness and trust are highly correlated (Colquitt et al., 2007; Mayer & Gavin, 2005). The supervisor has been shown "to be a particularly important referent of trust" (Dirks & Ferrin, 2002, p. 611), and meta-analytic research shows positive relationships of trust in the leader with both task performance and organizational citizenship behavior (Colquitt et al., 2007; Dirks & Ferrin, 2002).

Trust is important for safety. For example, Conchie and Donald (2009) found that safety-specific trust moderated the relationship between safety-specific transformational leadership and safety citizenship behaviors, such that the relationship was only significant when trust was moderate or high. Moreover, Conchie et al. (2012) found trust to mediate the relationship between safety-specific transformational leadership and safety citizenship behaviors. Finally, Conchie (2013) found that trust in the leader moderated the mediated relationship of safety-specific transformational leadership with whistle-blowing and safety voice via intrinsic motivation. In all of these three studies, trust was positively related to safety citizenship behaviors. Finally, Lofquist (2011) found that a loss of trust in leadership

led to ATCOs' resistance to change. Yet, initiating safety-related change is one dimension of safety citizenship behavior (Hofmann et al., 2003). To our knowledge, the relationship between trust(worthiness) and safety compliance has not directly been investigated. However, the positive relationship between trust in the leader and task performance has been confirmed convincingly (Colquitt et al., 2007; Dirks & Ferrin, 2002), whereby safety compliance resembles task performance in ATC.

Trust is also related to safety-related incidents (Baas, 2002) and patient safety (Verschueren et al., 2013), and it has the potential to enhance the present safety culture (Dejoy, 2005; Jeffcott et al., 2006), a major antecedent of safety behaviors (Beus et al., 2016). Within ATC, an important safety culture aspect is a *just culture*, reflecting "an atmosphere of trust where people are encouraged and even rewarded to provide essential safety-related information, but also in which it is clear where the line between acceptable and unacceptable behavior is drawn" (Fruhen et al., 2013, p. 328). Just culture is thus very similar to the concept of *psychological safety*. Trust in the supervisor is an important element of a just culture, which encourages reporting errors, mistakes, or near-misses, important safety behaviors in ATC (Fruhen et al., 2013).

Social exchange (Blau, 1964; Gouldner, 1960) has been proposed to explain the positive relationship between leaders' trustworthiness and employees' task performance and citizenship behavior (Colquitt et al., 2007). According to social exchange theory, trust is necessary for social exchange to occur (Blau, 1964). Additionally, "many of the facets of trustworthiness can be viewed as currencies that help create a social exchange. For example, trustworthiness facets such as demonstrating concern and support or acting based on sound principles can be viewed as actions that should engender a motivation to reciprocate on the part of an exchange partner" (Colquitt et al., 2007, p. 911). Indeed, trust would also instill the motivation to follow through on explicit and implicit rules (Stouten & Liden, 2020).

Following the norm of reciprocity (Gouldner, 1960), ATS employees are expected to react with safety compliance and safety citizenship behaviors to the favorable treatment by their supervisors, in this case reflected by their trustworthiness. Taken together, we propose:

Hypothesis 2a. Trustworthiness is positively related to ATS employees' safety compliance.

Hypothesis 2b. Trustworthiness is positively related to ATS employees' safety citizenship behavior.

Leader-Member Exchange

Leader-member exchange (LMX) reflects the degree to which a supervisor-employee dyad relationship is characterized by mutual respect, trust, and obligation, and therefore can be defined as a high-quality exchange relationship (Colquitt et al., 2014). Meta-analytic research confirms a positive relationship between LMX and job performance (Gerstner & Day, 1997) as well as OCB (Ilies et al., 2007).

In the safety literature, LMX has repeatedly been shown to relate positively to safety behavior, safety commitment, safety climate, and safety outcomes such as safety-related events and accidents (Donovan et al., 2016). Specifically concerning safety behavior, Hofmann et al. (2003) found that LMX was related to employee safety citizenship behavior. Moreover, several authors found LMX to relate positively to employee safety communication (Hofmann & Morgeson, 1999; Kath et al., 2010; Michael et al., 2006). Finally, (Yang et al., 2020) found LMX to be positively correlated with safety behavior, measuring it as combination of safety compliance and safety citizenship behavior.

In the ATC context, scholars also argued that LMX is important for safety. Coetzee and Henning (2019), referring to the ATC context, formulate it as follows: "An operational environment where all employees take responsibility and

continuously consider the impact of their decisions on safety relies on a high degree of mutual trust, respect and effective communication between employees and their leaders". They further argue that more than in other contexts, LMX is especially applicable in ATC "where high levels of authority, trust, cooperative interactions and information sharing are important" (Coetzee & Henning, 2019, p. 4). Additionally, Jiang et al. (2017) found a positive relationship between LMX and employees' safety citizenship behavior in a sample of ATCOs and airline maintenance employees.

LMX has been linked to outcomes based on social exchange theory (Ilies et al., 2007; Settoon et al., 1996). Indeed, social exchange theory explicitly deals with "mutually contingent exchange" (Blau, 1964, p. 164), relating very closely to LMX as relationship characterized by mutual exchange (Colquitt et al., 2014). Drawing on social exchange theory, employees are expected to feel obligated to reciprocate supervisors because of high-quality LMX. In an ATS context, this is expected to be expressed as employees' safety compliance and safety citizenship behavior, as argued for above. Accordingly, we hypothesize:

Hypothesis 3a. LMX is positively related to ATS employees' safety compliance.

Hypothesis 3b. LMX is positively related to ATS employees' safety citizenship behavior.

Supervisor Support for Safety

In the safety literature, an ongoing debate exists about whether to use general or safety-specific leadership when investigating safety-related outcomes (Conchie, 2013; Mullen & Kelloway, 2009). On the one hand, preliminary evidence suggests that safety-specific leadership has an incremental association with safety outcomes beyond general leadership (Mullen & Kelloway, 2009). On the other hand, scholars also argue that safety-specific leadership ignores leaders' non-safety-related tasks and its application might lead to a confounding of leadership and safety climate or employee safety behavior (Inness et al., 2010). Given that both

perspectives seem relevant, the current research incorporates both general leadership and safety-related leadership. Hence, we also examine perceived supervisor support for safety, which is defined as "the extent to which people believe their supervisor values safety as reflected in communication, encouragement, and consequences" (Christian et al., 2009, p. 1107).

Meta-analytic research shows that supervisor support for safety is significantly related to employees' safety behavior and safety outcomes such as accidents and injuries (Christian et al., 2009). For example, Hayes et al. (1998) and Thompson et al. (1998) found supervisors' safety support to be positively related to employees' safety compliance. Moreover, Simard and Marchand (1994) found supervisors' involvement in safety activities to be related to workers' safety compliance and safety initiative.

Additionally, a positive association between safety-specific transformational leadership and safety citizenship and compliance behavior has been shown (e.g., Conchie, 2013; Conchie & Donald, 2009; Mullen & Kelloway, 2009), such that Mirza and Isha (2017) even refer to it as "lead predictor of occupational safety". Safety-specific transformational leadership refers to "behaviour that is characteristic of the components of transformational leadership, yet specifically focused on inspiring and promoting positive safety-related practices" (Mullen & Kelloway, 2009, p. 255). Thus, this leadership style finds similarities with supervisor support for safety.

Moreover, managers' openness, norms, and reactions concerning safety reporting (reflecting safety support) play a relevant role in employees' incident reporting and raising of safety issues (Clarke, 1998; Mullen, 2005). As perceptions of management support for safety and supervisor support for safety are related (Thompson et al., 1998), we contend that this also translates into a positive association between supervisors' safety support and employees' safety behavior. Indeed, Probst and Estrada (2010) found that supervisors' safety enforcement was

related to less underreporting of accidents and fewer occurred accidents. As discussed above, incident reporting is an especially important aspect in ATC and is part of the just culture concept in the industry (Fruhen et al., 2013). Additionally, supervisor commitment to safety as perceived by ATS employees, a concept akin to supervisor safety support, has been found to be an important indicator of an ATS employees' perceived safety culture (Stroeve et al., 2011), which, in turn, is related to ATS employees' safety behavior (Schwarz & Kallus, 2015).

Theoretically speaking, Tucker et al. (2008) argue that support for safety triggers a safety-related social exchange process: "when supervisors and managers convey concern for employee safety by valuing suggestions for improving safety, workers develop beliefs that their organization has a positive orientation toward safety, which in turn increases the probability that workers will instigate or participate in safety-related exchanges [...] and participation in other safety-related activities". Thus, following the principles of social exchange theory (Blau, 1964; Gouldner, 1960), ATS employees are expected to reciprocate their supervisors' safety-supportive behavior by enacting safety compliance and safety citizenship behavior.

Moreover, a role modeling mechanism may account for the expected relationships. Following the definition given above, supervisor support for safety is reflected in supervisors' behavior expressing that they value safety. This would translate into supervisors' safety behavior, especially in the ATS context, where supervisors engage in front-line tasks as well. Following social learning theory (Bandura, 1977, 1986), leaders' behaviors are often modeled. Hence, safety-supportive behaviors of supervisors are expected to be modeled by ATS employees, which would encourage ATS employees' safety compliance and safety citizenship behavior. Taken together, we formulate:

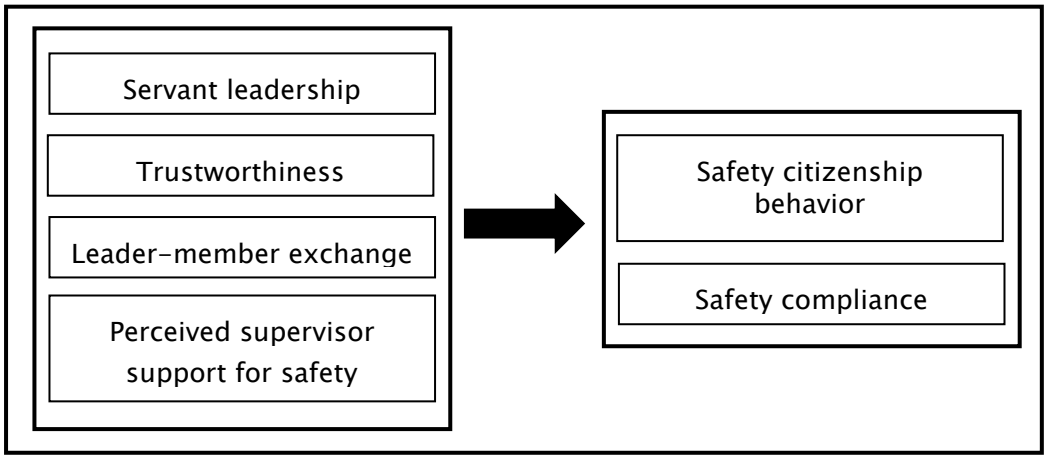
Hypothesis 4a. Perceived supervisor support for safety is positively related to ATS employees' safety compliance.

Hypothesis 4b. Perceived supervisor support for safety is positively related to ATS employees' safety citizenship behavior.

The conceptual research model is depicted in Figure 2.1.

Figure 2.1

Conceptual Research Model



Method

Study Environment

We conducted the study with operational air traffic safety (ATS) employees from a European air navigation service provider (ANSP). The ANSP entails different units. The two air traffic control (ATC) center units "ATC center 1" (42.2% of all ATS employees) and "ATC center 2" (11.8% of all ATS employees) and the largest tower unit "tower 1" (16.7% of all ATS employees) have between 12 and 21 supervisors each. There is/are nearly always one supervisor (in ATC center 2 and tower 1) or two supervisors (in ATC center 1) present in the operational room, and they are mainly tasked with operational supervisory roles (e.g., taking decisions concerning runways usage). By contrast, the five regional towers (in total 29.3% of all ATS employees) have one or two supervisors in total, who primarily have a

coordinating/organizing role (e.g., administrative support, coordinating acitivities with the airport), and who are not present all the time.

Most supervisors also act as ATS employees, depending on the shift. This implies that during some shifts they are in the supervisor role, whereas in other shifts they are in the ATS employee role. This is the case in the regional towers and in ATC center 2 (for all supervisors), in ATC center 1 (for all supervisors but one) and in tower 1 (for only two supervisors). It shows the complexity of the organization, in which multiple locations and supervisor roles are dispersed. Finally, in none of the units there is a fixed team structure, such that team compositions change every shift.

Study Design

We applied a diary study design in order to test our research model. By conducting a diary study in the described context, we aimed to investigate leadership associations via differences in leadership behavior and safety variables within-employees and thereby to rule out differences between employees affecting the results. Studying leadership on a daily basis is a recent trend, which has important benefits and has shown that leadership fluctuates daily; hence, a diary-study approach is encouraged (Kelemen et al., 2019). To obtain enough data while not overwhelming our participants, we chose for five measurements. These referred to five consecutive shifts for each employee, and had to be completed towards the end of or after each shift.

Participants

The 287 ATS employees working at the ANSP formed the pool of potential participants that were invited to participate, and included a) 230 air traffic controllers (ATCOs), b) 23 employees of the flight data services (FDS), partly also working as operational employees of the flight information center (FIC), also called

flight information service officers (FISOs), c) 27 on-the-job trainees (OJTs), and d) 6 aerodrome flight information service officers (AFISOs).

Initially, 82 employees participated in the study, reflecting 28.6% of the sample. Of these, eleven only opened the introductory page of the survey, one stopped at the informed consent, and nineteen did not continue after demographic/shift questions. Furthermore, two participants did not reply correctly to any of our two attention checks ("Please select option 'Strongly disagree'"). We excluded all these participants from our analysis, yielding a useable sample of 49 employees and an effective response rate of 17.1%.

Further, a high dropout rate throughout the diary study was observed. We checked whether participants completed all five diary surveys at the same day and if this was the case, we excluded those participants' day 2 to 5 survey data from the analyses. This concerned four participants. Considering those, 10 participants stopped during day 1, while 39 finished at least day 1. Of these 39, only 18 started day 2, of which also 13 finished it. Of these 13, eight started, of which seven finished day 3. Of these, five started and finished day 4, of which all started and four finished day 5.

Of the 49 useable initial participants, 38 were male (77.6%) and 10 female (20.4%; one participant (2.0%) indicated "Other / do not want to answer"). On average, participants were 40.61 years old (SD = 8.53) and worked for 16.37 years for the ANSP (SD = 8.22). Most of the participants indicated secondary education as their highest obtained degree (46.9%), while 28.6% indicated a bachelor's and 20.4% indicated a master's degree. Two participants indicated an "other" degree (4.1%). While 44.9% worked in ATC center 1 and 10.2% in ATC center 2, 18.4% worked in tower 1 and 26.5% in one of the regional units. Most participants worked mainly as

area controller (38.8%), approach controller (20.4%), or tower controller (20.4%), while some mainly worked as FDS, FIC/FISO (each 6.1%), OJT, or AFISO (each 4.1%).[4]

Procedure

Before the actual data collection, the first author visited the different units to familiarize with the context and inform ATS employees and supervisors about the research. She also informed employees from the safety, human resources, and human factors department, as well as senior managers about the research. From several of these employees, she collected input on the research topics and questionnaire in order to ensure that participants were fully informed, the survey structure was optimized, and the content was motivating for participants and relevant to the context, while still including valid measures from the literature.

One week before the data collection, all ATS employees were informed about the research, its purpose, and the coming data collection via email. At the start of the data collection, they received a link to an online survey, and the explanation that it would need to be completed towards the end of or after each of the next five consecutive shifts. The online survey consisted of one longer version and subsequently four times a shorter version (for each of the consecutive days). At the end of each questionnaire page, an open comment field allowed the respondents to add any additional information or comments. All communication and questions were in English, the corporate language. During the data collection, the first author visited the units to inform participants about the study, ask input, and answer questions. After the data collection and analyses, the first author conducted interviews to contextualize the findings and support their interpretation.

Measures

All items were rated on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*), except for the control variables and measures of safety citizenship behavior

[4] Unit and position were taken from day 1 of the diary study.

and safety compliance, which were indexed from 1 (*never*) to 5 (*very frequently*). All measures were assessed daily, except the control variables, which were only assessed at the first measurement. We instructed employees to refer to their behavior, motivations, and evaluations during their last shift and concerning their last shift's supervisor. We relied on validated scales, adapted to the diary study design and the ATC context where necessary.

Servant Leadership

To measure servant leadership of the supervisor, we used the seven-item short form of the servant leadership measure (Liden et al., 2008). To tailor it to our context, we replaced the word "manager" by "supervisor". An example item is: "I would seek help from my supervisor if I had a personal problem". Cronbach's alpha for that scale is .84.[5]

Trustworthiness

To measure trustworthiness on a daily basis, we used the three-item measure of trustworthiness developed by Jones and Shah (2016). Instead of using names, we referred to *supervisor*. Additionally, we transformed the questions into statements and asked for the extent of agreement. For example, we changed the item "To what extent does [first name] have the ability to complete high quality work—does [he/she] have the knowledge and skills needed?" to "Your supervisor has the ability to complete high quality work—he/she has the knowledge and skills needed". The scale's Cronbach alpha is .95.

Leader-Member Exchange

We measured LMX with the social exchange relationship scale (SERS) of Colquitt and colleagues (2014). The SERS measures social exchange by asking whether the relationship with one's supervisor is characterized by mutual obligation, trust, commitment, and significance. Following Mawritz et al. (2017), we asked

[5] The Cronbach's alphas were estimated based on the original data of day 1.

employees to rate their (dis)agreement with the four characterizations of their relationship with their supervisor. The scale's alpha reliability is .78.

Perceived Supervisor Support for Safety

We used a three-item measure developed by Tucker and colleagues (2008) measuring perceived coworker support for safety, and changed the words "coworkers" and "colleagues" to "supervisor" to measure perceived supervisor support for safety. An example item is: "My supervisor encourages others to work safely". Cronbach's alpha for that scale is .80.

Safety Compliance

Safety compliance is often measured with a four-item scale developed by Neal et al. (2000). However, the items do not apply to the ATC context. For example, as safety is so critical in ATC, all ATS employees would most probably strongly agree with the item "I carry out my work in a safe manner". Therefore, we did not use the scale of Neal et al. (2000), but used four items from the ATCO competency framework instead. This framework includes ten crucial competencies for ATS employees, more specific competence elements, and observable behaviors reflecting these competence elements. It has been thoroughly developed by the ANSP in collaboration with the International Civil Aviation Organisation in compliance with EU regulation 2015/340 (2015). The items we used reflect five overt behaviors referring to four different competences, which fit the definition of safety compliance as maintaining workplace safety by carrying out basic safety activities prescribed by the job (Griffin & Neal, 2000) the best. An example item is "Applying appropriate air traffic separation and spacing". All items measuring safety compliance can be found in Table 2.1. Cronbach's alpha for that scale is .80.

Safety Citizenship Behavior

To assess safety citizenship behaviors, we used items of a scale developed by Hofmann and colleagues (2003). In discussion with ATS experts, we chose the most

relevant behaviors for the ATC context. Additionally, one slightly adapted item from the ATCO competency framework was added to replace two items of the *civic virtue* dimension of Hofmann and colleagues (2003), as their reference to "safety meetings" does not make sense in ATC. The *whistleblowing* and *stewardship* dimensions were not included, as these behaviors rarely or never occur in ATC. All items measuring safety citizenship behavior can be found in Table 1. The scale's Cronbach alpha is .87.

Table 2.1

Safety Compliance and Safety Citizenship Behavior Items

Construct	Source	Dimension	Item
Safety compliance	ATCO competency framework		Managing arriving, departing and/or en route traffic using prescribed procedures
			Applying appropriate air traffic separation and spacing
			Verifying accuracy of readbacks and correct as necessary
			Following prescribed procedures for communication and coordination of urgent situations.
			Coordinating the movement, control and transfer of control for flights using the prescribed coordination procedures
Safety citizenship behavior	Hofmann et al., 2003	Helping	Assisting others to make sure they perform their work safely
			Helping others with safety-related responsibilities
		Voice	Making safety-related recommendations about work activities
			Expressing opinions on safety matters even if others disagree
		Initiating safety-	Trying to change the way the job is done to make it safer

Table 2.1

Safety Compliance and Safety Citizenship Behavior Items

Construct	Source	Dimension	Item
		related change	Trying to change policies and procedures to make them safer
		Civic virtue (Keeping informed)	Keeping informed of changes in safety policies and procedures
	ATCO competency framework		Maintaining, through personal initiative, good knowledge of aviation safety evolution

Note. The stem for these items was: "How often have you engaged in the following behaviors today?"

Control Variables

We accounted for several alternative explanations and possibly confounding variables that emerge in the literature by including different control variables. First, we controlled for demographics, namely age, gender, and highest degree obtained, as they relate to safety behavior (e.g., Kark et al., 2015; Pek et al., 2017). Second, we controlled for work experience at the ANSP, as it has been found to be negatively related to trust in supervisors in an ATC sample (Cho & Park, 2011), and at the same time "experience is a critical factor in aviation safety" (Coetzee & Henning, 2019, p. 2). Lastly, we controlled for the unit, the main position during the last work shift (area controller, approach controller, tower controller, or "other" (FDS, FIC/FISO, OJT, or AFISO)), and the kind of this shift (week or weekend/holiday, and early, day, late or night). We tested for associations between the control variables and our study variables to assess whether they should be controlled for while testing our hypotheses.

Analysis Strategy

Due to the low sample size, rather than to aggregate to the supervisor level, we treated all variables at the individual level. Furthermore, the initially planned

crossed random effects models (as days are nested within respondents due to the diary study design and days are nested within supervisors) were also unfortunately not permitted with our small sample size. Therefore, we restricted ourselves to descriptives, correlations, and multiple regression analyses. While the descriptives present participants' means, standard deviations, and proportions of their responses on the different days, the correlations and regression analyses were based on the responses on day 1 only, as the number of participants on days two to five did not allow for multilevel analyses. We performed hierarchical regression analyses adding control variables in step 1 and predictors in step 2 to investigate whether the leadership aspects were associated with ATS employees' safety compliance and safety citizenship behavior beyond the associations between the control variables and outcomes.

For the categorical variables with more than two categories (i.e., unit, position, and day shift), we formed dummy variables, representing (1) the units tower 1, regional unit, or ATC center 2 (with ATC center 1 as reference), (2) the positions area controller, approach controller, or tower controller (aggregating all other positions as "other" category and reference), and (3) intermediate, late, or night shift (with early shift as reference).

We checked whether the occurrence of missing data was related to other data that was measured in the dataset, by computing t-tests investigating whether participants who finished at least the day 1 survey and participants who did not finish it differed in terms of their demographics, work experience at the ANSP, dependent, or independent variables. We found a significant difference between those two groups, that is, participants who stopped during the day 1 survey had a higher trustworthiness towards their supervisor ($t(42) = 2.11$, $p = .03$). Consequently, the data is not missing completely at random, meaning that "the probability that a variable value is missing does not depend on the observed data

values nor on the missing data values" (Newman, 2014, p. 376). To approach item- and construct-level missing data at day 1, we applied a multiple imputation analysis, as has been recommended in the literature (Enders, 2010; Newman, 2014). The advantage of this analysis is that bias and error due to missing data is reduced (Newman, 2014). We applied 50 imputations (Enders, 2010) and applied an item-level (as opposed to construct-level) imputation to incomplete items (Gottschall et al., 2012). We added all items measuring independent, dependent, or control variables, and a variable indicating at which point in the survey participants dropped out as auxiliary variable, to take into account that most missing values occurred due to drop out. The reported results are for the pooled multiple imputation set, unless otherwise specified.

Additionally, multicollinearity was checked by investigating the predictors' variance inflation factors (*VIFs*). Moreover, we performed a post-hoc power-analysis with G*Power 3.1 (Faul et al., 2009) to assess the observed power of the linear multiple regression (fixed model, R^2 increase after entering the control variables). We excluded one participant's responses on the diary variables of day 1, because (s)he gave as a comment "I did not work today".

Results

Table 2.2 presents the correlations of the study variables of the day 1 survey and Table 2.3 presents the sample sizes, manifestation frequencies, means, and standard deviations of all survey days.

Table 2.2

Correlations of Study Variables on Day 1

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Age																			
2. Gender[a]	.08																		
3. Degree	.02	.05																	
4. ANSP work experience	.66**	.13	−.07																
5. Regional unit[b]	−.08	.07	−.21	−.15															
6. Tower 1[b]	−.30*	−.25	−.02	−.20	−.29*														
7. ATC center 2[b]	.22	−.01	−.05	.32*	−.20	−.16													
8. Intermediate shift[c]	−.21	.11	−.19	−.29*	.48**	−.18	−.13												
9. Late shift[c]	−.02	−.25	.02	.04	−.22	−.11	.05	−.26											
10. Night shift[c]	−.14	.05	−.02	.08	.03	.05	.09	−.24	−.44**										
11. Week vs weekend shift[d]	−.14	−.02	.02	−.26	.30*	−.15	.12	.37**	−.09	.17									
12. Tower controller[e]	−.47**	−.09	−.15	−.35*	.27	.41**	−.17	.12	−.03	.13	.18								
13. Approach controller[e]	.24	.11	−.08	.34*	.38**	−.24	.50**	.12	−.14	.13	.18	−.26*							
14. Area controller[e]	.26	.10	−.05	.42**	−.48**	−.16	−.13	−.30*	.16	.05	−.36*	−.40**	−.40**						
15. Servant leadership	−.05	−.10	.24	.10	−.35*	.11	.26	−.27	−.04	.10	.12	−.01	−.12	.16					
16. Trustworthiness	.11	−.16	.27	.18	−.47**	.06	.20	−.30*	.03	.02	.07	−.22	−.13	.27	.84**				
17. LMX	.07	−.09	.40**	.19	−.37*	.07	.14	−.38**	.19	−.03	−.17	−.29	−.03	.17	.57**	.52**			
18. Supervisor support for safety	.28	.01	.29	.36*	−.15	−.03	.18	−.23	−.07	.02	−.17	−.27	.23	.07	.44**	.42**	.51**		
19. Safety compliance	.19	.16	−.04	.41**	−.14	.11	.11	−.23	.12	.04	−.28	.00	−.09	.23	.17	.13	.15	.19	
20. Safety citizenship behavior	.04	.15	−.10	.21	.02	−.06	.11	−.14	−.07	.05	−.29*	−.03	−.03	.06	.14	−.02	.20	.25	.49**

Table 2.2

Correlations of Study Variables on Day 1

Note. $N = 49$ (pooled imputed data of day 1).

[a] Gender is coded as 0 for males and 1 for females.

[b] The unit variables are dummy-coded, such that 1 refers to employees working in the respective unit and 0 to employees working in another unit.

[c] The shift variables are dummy-coded, such that 1 refers to employees working in the respective shift and 0 to all employees working in another shift.

[d] Week vs. weekend shift is coded as 0 during the week and as 1 during the weekend.

[e] The position variables are dummy-coded, such that 1 refers to employees working in the respective position and 0 to all employees working in another position.

* $p < .05$, ** $p < .01$ (2-tailed).

Table 2.3

Sample Sizes, Sample Proportions, Means, and Standard Deviations of the Study Variables per Day

	Day 1 imp.			Day 1			Day 2				Day 3				Day 4				Day 5			
	%₁	*M*	*n*	*%₁*	*M*	*SD*	*n*	*%₁*	*M*	*SD*	*n*	*%₁*	*M*	*SD*	*n*	*%₁*	*M*	*SD*	*n*	*%₁*	*M*	*SD*
Age	–	40.61	49	–	40.61	8.53	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gender[a]	21.2	–	48	20.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Degree	–	1.74	47	–	1.72	0.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ANSP work experience	–	16.37	49	–	16.37	8.22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Regional unit[b]	26.5	–	49	26.5	–	–	18	22.2	–	–	8	25.0	–	–	6	33.3	–	–	5	20.0	–	–
Tower 1[b]	18.4	–	49	18.4	–	–	18	22.2	–	–	8	12.5	–	–	6	33.3	–	–	5	40.0	–	–
ATC center 2[b]	10.2	–	49	10.2	–	–	18	27.8	–	–	8	25.0	–	–	6	16.7	–	–	5	40.0	–	–
Intermediate shift[c]	12.2	–	49	12.2	–	–	18	0.0	–	–	8	0.0	–	–	5	0.0	–	–	5	0.0	–	–
Late shift[c]	32.7	–	49	32.7	–	–	18	44.4	–	–	8	0.0	–	–	5	40.0	–	–	5	20.0	–	–
Night shift[c]	28.6	–	49	28.6	–	–	18	44.4	–	–	8	37.5	–	–	5	0.0	–	–	5	0.0	–	–
Week vs weekend shift[d]	24.5	–	49	24.5	–	–	18	38.9	–	–	8	25.0	–	–	5	0.0	–	–	5	20.0	–	–
Tower controller[e]	20.4	–	49	20.4	–	–	18	16.7	–	–	8	25.0	–	–	6	33.3	–	–	5	40.0	–	–
Approach controller[e]	20.4	–	49	20.4	–	–	18	22.2	–	–	8	12.5	–	–	6	16.7	–	–	5	20.0	–	–
Area controller[e]	38.8	–	49	38.8	–	–	18	38.9	–	–	8	50.0	–	–	6	33.3	–	–	5	40.0	–	–
Servant leadership	–	4.94	44	–	4.94	1.13	13	–	5.07	1.39	7	–	4.96	0.68	5	–	4.94	0.75	4	–	5.36	0.72
Trustworthiness	–	5.57	44	–	5.58	1.21	13	–	5.13	1.81	7	–	4.71	1.30	5	–	5.20	0.77	4	–	5.67	0.67
LMX	–	5.64	41	–	5.65	0.82	13	–	5.10	1.07	7	–	5.07	0.66	5	–	5.05	0.76	4	–	5.44	0.92
Supervisor support for safety	–	5.33	41	–	5.33	0.96	13	–	5.13	1.24	7	–	4.95	1.41	5	–	5.20	0.69	4	–	5.42	0.79
Safety compliance	–	4.45	45	–	4.48	0.64	13	–	4.40	.68	7	–	4.42	0.94	5	–	4.84	0.36	5	–	4.60	0.79
Safety citizenship behavior	–	2.68	47	–	2.68	0.79	13	–	2.89	.53	7	–	2.27	0.65	5	–	3.00	0.80	5	–	2.60	0.83

Table 2.3

Sample Sizes, Sample Proportions, Means, and Standard Deviations of the Study Variables per Day

Note. Age, gender, degree, and ANSP experience were only assessed at day 1. Day 1 to 5 present the descriptives of the original data, while *Day 1 imp.* presents the descriptives of the pooled imputed data of day 1 ($N = 49$; pooled data does not deliver *SD*s).

%1 refers to the valid percentage of respondents scoring '1' on the variable.

[a] Gender is coded as 0 for males and 1 for females.

[b] The unit variables are dummy-coded, such that 1 refers to employees working in the respective unit and 0 to employees working in another unit.

[c] The shift variables are dummy-coded, such that 1 refers to employees working in the respective shift and 0 to employees working in another shift.

[d] Week vs. weekend shift is coded as 0 during the week and as 1 during the weekend.

[e] The position variables are dummy-coded, such that 1 refers to employees working in the respective position and 0 to employees working in another position.

As can be seen from Table 2.2, servant leadership, trustworthiness, LMX, and supervisor support for safety were all strongly correlated (r between .42 and .84, p in each case $< .01$). Moreover, the safety behaviors (i.e., safety compliance and safety citizenship behavior) were strongly correlated ($r = .49$, $p < .01$). Finally, two control variables were correlated with one of the outcome variables. Work experience at the ANSP was strongly correlated with safety compliance ($r = .41$, $p < .01$), such that more experience was associated with more safety compliance behavior. Week vs. weekend shift was related to safety citizenship behavior ($r = -.29$, $p = .04$), such that weekend shifts were related to lower safety citizenship behavior.

Main Analyses

As proposed in the literature, we restricted the control variables in our main analyses to those that showed significant relations with the dependent variables (i.e., safety compliance and/or safety citizenship behavior; Becker, 2005). Table 2.4 presents the results of the hierarchical regression analyses, including the unstandardized regression coefficients of the predictors on the two dependent variables, while controlling for work experience at the ANSP and week vs. weekend shift.

Table 2.4

Hierarchical Multiple Regression Analyses Predicting Safety Compliance and Safety Citizenship Behavior From Servant Leadership, Trustworthiness, LMX, and Supervisor Support for Safety

		DV: Safety compliance				DV: Safety citizenship behavior			
Model		*b (SE)*	*t*	$\overline{R^2}$	$\overline{\Delta R^2}$	*b (SE)*	*t*	$\overline{R^2}$	$\overline{\Delta R^2}$
Step 1	(Constant)	4.35*** (.32)	13.47	.20		3.03*** (.45)	6.69	.11	
	ANSP work experience	0.03* (.01)	2.55			0.01 (.01)	0.99		
	Week vs. weekend shift	−0.25 (.19)	−1.33			−0.46 (.26)	−1.77		
Step 2	(Constant)	4.30*** (.72)	5.98	.24	.04	2.33* (.99)	2.36	.24	.13
	ANSP work experience	0.03* (.01)	2.35			0.01 (.01)	0.89		
	Week vs. weekend shift	−0.30 (.20)	−1.51			−0.45 (.27)	−1.70		
	Servant leadership	0.17 (.15)	1.18			0.39 (.21)	1.83		
	Trustworthiness	−0.08 (.13)	−0.59			−0.37* (.19)	−2.01		
	LMX	−0.03 (.14)	−0.23			0.06 (.19)	0.29		
	Supervisor support for safety	−0.03 (.11)	−0.25			0.11 (.16)	0.69		

Note. DV = Dependent variable; $N = 49$ (pooled imputed data of day 1).
* $p < .05$. *** $p < .001$.

Concerning the control variables in step 1, work experience at the ANSP was significantly related to safety compliance ($b = 0.03$, $p = .01$), but not to safety citizenship behavior ($b = 0.01$, $p = .32$). Week vs. weekend shift was neither significantly related to safety compliance ($b = -0.25$, $p = .18$), nor to safety citizenship behavior ($b = -0.46$, $p = .08$). Thus, we only found support for a (positive) relationship between work experience at the ANSP and safety compliance.

The results showed *no* significant associations between servant leadership on the one hand and safety compliance ($b = .17$, $p = .24$) and safety citizenship

behavior (b = .39, p = .07) on the other, after controlling for work experience at the ANSP and week vs. weekend shift. Thus, *no* support was found for Hypotheses 1a and 1b.

Trustworthiness was *not* significantly related to safety compliance (b = -.08, p = .56), but did reveal a significant, unexpected *negative*, relation with safety citizenship behavior (b = -.37, p = .05), after controlling for work experience at the ANSP and week vs. weekend shift. Hence, *no* support was found for Hypotheses 2a and 2b.

The results showed *no* significant associations between LMX on the one hand and safety compliance (b = -.03, p = .82) and safety citizenship behavior (b = .06, p = .78) on the other, after controlling for work experience at the ANSP and week vs. weekend shift. Thus, *no* support was found for Hypotheses 3a and 3b.

Finally, perceived supervisor support for safety was neither related to safety compliance (b = -.03, p = .81) nor to safety citizenship behavior (b = .11, p = .49), after controlling for work experience at the ANSP and week vs. weekend shift. Therefore, there was *no* support found for Hypotheses 4a and 4b.

Additional Quantitative Analyses

The highly significant correlations between the leadership concepts might indicate a problem with multicollinearity. However, additional analyses indicated the *VIF* for the different leadership variables to be between 1.36 and 3.58[6] and thus below the commonly used cut-off points of 5 or 10 (McEvoy, 2018).

The post-hoc power-analysis revealed a power of .20 for safety compliance (effect size f^2 = .05) and .58 for safety citizenship behavior (effect size f^2 = .17). Thus, the chance of finding significant results in case they actually existed is estimated at only 20% for safety compliance and 58% for safety citizenship behavior,

[6] Based on the original data

rendering a high probability of not finding significant relationships even if those would, in fact, be present in the larger population.

Post-Hoc Interviews and Open Comment Fields

To further contextualise and interpret the findings as well as derive insights about possible explanations and implications, the first author interviewed people holding various positions at the ANSP where the current research was conducted. In addition, the contents of open fields of the questionnaire were considered. Eleven interviews were conducted, of which eight one-on-one and three group interviews; Table 2.5 shows an overview of all invitees and participants. Of the non-operational employees, many had worked as ATS employees and/or supervisors in the past (i.e., part of the director's committee, the human factors specialists, part of the safety unit, the senior manager). During the interviews, the first author presented the results and asked for possible interpretations, contextualization, and suggestions for implications.

Table 2.5
Overview of Employees Who Have Been Invited and Who Participated in Interviews

Invited	Participated
Director's committee	Director's committee (group interview)
Human factors specialists ($n = 2$)	Human factors specialists ($n = 2$; group interview)
HR department	One employee of the HR department
Safety department	15 employees of the safety department (group and two individual interviews)
ATS employees and supervisors	One ATC center 1 supervisor
Senior managers	One senior manager
Senior potentials (ATCOs and/or supervisors with a coordinating, management-supporting role)	Three senior potentials (individual interviews)

Supervisors' Leadership Role and Behavior

The interviews delivered important insights pertaining to the leadership role and behavior of supervisors. Supervisors' leadership behavior may be limited due to various reasons that relate to supervisors' role definition. For example, during some interviews, supervisors' feedback-giving was discussed, which in the general and safety literature is regarded as essential leadership behavior that increases employees' general task performance (Larson, 1984) and safety behavior (Zohar & Luria, 2003). Feedback-giving of supervisors was indicated to be present only to a very limited extent in the ANSP. This was partly attributed to the rotating leadership system during the interviews, which can also be illustrated by an ATS employee's note in an open comment field throughout the survey: "we don't receive feedback from supervisor. They are one day supervisor and another day our direct colleague. So as far as possible they won't criticize or give any feedback". Thus, supervisors may perceive it as difficult to take up a leadership role in a rotating leadership system and consequently may be reluctant to do so. Additionally, the fact that supervisors are (former) ATS employees was mentioned to possibly play a role in supervisors' reluctance to take up a leadership role. Following that reasoning, the transition from colleague to leader would be difficult, especially in combination with a rotating leadership system where the transition of roles is not permanent.

Moreover, interviewees indicated that many supervisors may not perceive giving feedback as part of their role. Also, more generally, ATS supervisors' role definition seems to lack leadership aspects. For example, ATS supervisors' job descriptions and trainings mainly include coordinating and operational but scarcely leadership aspects. Relatedly, supervisors are often not seen as "leaders". For example, in an open comment field at the end of the survey, an ATS employee asked: "can we do the same survey concerning middle and high management? not a

supervisor who is practically a member of the team?" (sic). This illustrates that supervisors seem to be regarded as team-members rather than team-leaders.

Summarizing, supervisors' role definition seems to lack leadership aspects, which may make them reluctant to engage in leadership. Yet, in combination with their appointment as supervisors, they may lack role clarity. The lack of clarity about ATS supervisors' leadership role may possibly account for the non-significant relationships between leadership aspects and safety behavior.

The Role of Other Job Functions

Another aspect that could lead to a reduced leadership role and role clarity of the supervisors in the ANSP is that besides the supervisors, operations-coordinators (ops-coordinators) and senior potentials exist. Ops-coordinators are air traffic controllers and/or supervisors who also have operational management responsibilities. They manage the operations to aim for operational excellence, for example by coordinating with other units and stakeholders and striving for long-term operational improvements. Senior potentials receive management training and link senior managers and operations, while still working as air traffic controllers and/or supervisors. The existence of these functions may lead to a diffusion of leadership between them and supervisors. For example, one interviewee was convinced that ATS employees would rather approach the ops-coordinators than their supervisor when experiencing personal problems.

Moreover, the interviews indicated that ATS employees work more closely together with their colleagues and are more dependent on them than on supervisors. Specifically, while two interviewees did find feedback from supervisors useful, three interviewees thought that feedback from colleagues was more important, as colleagues would have a better view on ATS employees' behavior or supervisors do not have the knowledge of the needed behavior or the needed overview of the traffic situation. It is striking that ATS supervisors seem to be

perceived as not having enough knowledge of the needed behavior and/or situation at hand. This resembles the specificity of the ATC context, where ATS employees have the best picture of the traffic they are responsible for. It may highlight the difficulty for a supervisor to take up their leadership role and have an impact on ATS employees.

ATS Employees' Needs From Supervisors

Interviewees who either currently worked or in the past had worked as ATS employees and/or supervisors were asked what ATS employees need from their supervisors. They answered that supervisors need to provide guidance and ensure that ATS employees can perform their work under ideal circumstances (e.g., ideal aircraft capacity). Moreover, supervisors should provide support, in general and even more so for OJTs. More direct communication between supervisor and ATS employees was also mentioned as supporting factor.

Other Factors and Constraints

Safety citizenship behavior may be restricted by organizational constraints as mentioned during the interviews and by an ATS employee in an open comment field at the end of the survey: "while safety is important and it is a constant thing 'to do', its not something we literally work on all day to improve, there is an operational and management limit to this, and there is clearly no use in pushing further since reports are ignored and there is never feedback received. we continue to do our job safely, even though we try and have tried fruitlessly to address some issues, to no avail" (sic). These organizational constraints that seem to discourage safety citizenship behavior may lead to a difficulty for supervisors to promote ATS employees' safety citizenship behavior.

Repeatedly, interviewees mentioned the significant differences of the supervisor role and system in the different units. It is possible that these differences lead to leadership – safety behavior relationship discrepancies between units.

Indeed, in the regional units, supervisors have a preliminary coordinating/organizing role and are not present in the operational room during their supervisor shifts, while in the largest tower unit and the ATC center, supervisors have an operational role and are present in the operational room. The relationship between leadership and safety may depend on the supervisor role and circumstances.

How to Support Supervisors

Finally, it was also discussed how ATS supervisors may be supported in their role. Most often, organizing adequate training and/or coaching for ATS employees who become supervisors was suggested. Indeed, ATS employees often become supervisor based on their experience, often lacking knowledge and/or skills in leadership. A second aspect that has been mentioned to support supervisors was to increase their role clarity by delineating what is expected of them and include leadership aspects to their role definition by adding them to the operations manual or job descriptions.

Discussion

The purpose of the current research was to examine the relationship between different leadership aspects at the supervisor level and employees' safety behavior in the air traffic control (ATC) context. We focused on servant leadership, trustworthiness, leader-member exchange (LMX), and supervisor support for safety on the one hand, and air traffic safety (ATS) employees' safety compliance and safety citizenship behavior on the other hand.

Theoretical Implications

First of all, none of the hypothesized relationships were supported. Most likely, the low response rate and consequently low power possibly account for the non-significant findings. Unpublished survey data from 228 ATS employees of the

air navigation service provider (ANSP) where the current study took place showed a negative relationship between ATS employees' fatigue and respectively trust in (r = -.19, $p < .01$) and servant leadership of top management (r = -.21, $p < .01$).[7] Therefore, as even the more distant top management seems to relate to ATS employees' safety aspects (i.e., fatigue), this would warrant a closer examination of immediate supervisors, too. Moreover, interviewees suggested that ATS employees would need guidance and support from their supervisors (especially on-the-job trainees) as well as the provision of ideal circumstances. This could be resembled by servant leadership and, therefore, would suggest a relationship between servant leadership and ATS employees' safety behavior, which could not be detected in the data. Hence, the low sample may indeed account for the unsupported findings.

Alternatively, it may be that in the specific ATC context, different processes play a role than in other industries. Our findings may suggest that in ATC either other agents are more likely to be main sources of role modeling and social exchange, or the outcomes of the two processes are different from safety behavior. For example, ATS employees' safety behavior may be more strongly related to the behavior of operations-coordinators, senior potentials, or colleagues than to the behavior of the supervisor on that particular day (given that supervisors rotate). As suggested during the interviews and also noticed during the first author's observations of the operations, ATS employees do indeed work more closely together with their colleagues than their supervisors. In the literature, it has been argued that in settings where colleagues are proximately closer than supervisors, colleagues have a strong referent and expert power, and the supervisor is not always available (which indeed is true for ATC), the safety communication of colleagues may be more salient than that of supervisors (Tucker et al., 2008). This

[7] Additional information about the method of this data collection can be found in Appendix 1 at the end of this chapter.

may position colleagues more likely to become role models and/or social exchange partners in ATC. Moreover, the outcomes of role modeling and social exchange may be more directed towards the supervisor or colleagues, reflecting aspects such as trust, commitment, and cooperative or friendly behavior.

Furthermore, the interview results suggest that ATS supervisors' role definition may scarcely include leadership aspects due to various possible reasons. The rotating leadership system in some units, the related difficulty of the transition from colleague to supervisor, and the lack of leadership tasks in supervisor job descriptions and trainings were all mentioned during the interviews and may possibly relate to role unclarity and perceptions that the supervisor role does not imply leadership. Moreover, the co-existence of other job functions with a potential leadership role (i.e., operations-coordinators and senior potentials) may diffuse supervisors' leadership responsibility. In turn, this unclarity and lack of leadership in the role definition may hinder a relationship between supervisors' leadership aspects and ATS employees' safety behavior. This would be in line with findings from the literature showing that the extent to which supervisors' role definition includes responsibility for employees' safety behavior and safety relates positively to supervisors' safety leadership (Conchie et al., 2013), supervisors' safety-related interactions with employees, and employees' safety compliance (Zohar & Luria, 2003).

Not only may organizational factors restrict supervisors' leadership, but they may also restrict employees' safety behavior, as mentioned during the interviews using the example of the organization's limited processing of safety-related suggestions that would discourage making safety-related suggestions, a safety citizenship behavior. The literature, too, corroborates the importance of organizational factors for employees' safety behavior (Beus et al., 2016). Consequently, organizational constraints may also hinder the relationship between

supervisors' leadership and ATS employees' safety behavior. For example, if ATS employee have the impression that the safety-related suggestions they make are not processed by the organization, a supervisor may not be able to stimulate safety-related suggestions. However, the current study's data indicates that ATS employees do enact safety citizenship behavior (to some extent) on a daily basis, with means ranging from 2.27 to 3.00 (on a scale from 1 (*never*) to 5 (*very frequently*)) on different days. Nevertheless, the moderating role of organizational constraints warrants further investigation.

Surprisingly, the results indicate that trustworthiness is associated with *lower* safety citizenship behavior. As the correlation between trustworthiness and safety citizenship behavior is nearly 0, it seems to be important to test trustworthiness together with the control variables and the other leadership aspects in one model. That way, we controlled for the overlap between the leadership aspects and discovered the negative relationship between the unique part of trustworthiness and safety citizenship behavior. A reason for this negative relationship might be that ATS employees believe trustworthy supervisors take care of everything, and thus enact lower safety behavior themselves. Indeed, trust in the supervisor may decrease the perception of risk at the workplace (Kivimäki et al., 1995), which, in turn, relates to lower safety compliance and safety participation (Xia et al., 2017). Moreover, scholars have found that too much trust can have negative effects for performance, either by arguing for a curvilinear relationship between trust and performance, or for negative effects of trust besides its positive effects (Bammens & Collewaert, 2014). This has also been confirmed in safety research, where "blind trust […] would be detrimental for safety" (Tharaldsen et al., 2010, p. 1063). Completely trusting others may increase the risk for safety incidents due to a reduced personal responsibility for safety and, by consequence, a reduced alertness towards unsafe conditions (Conchie & Donald, 2008). Generally, excessive trust is

closely associated with blind faith and unchallenged loyalty (Stevens et al., 2015). Possibly, in ATC, a social exchange mechanism is in place where trustworthiness of the supervisor is replied with blind faith or unchallenged loyalty of ATS employees. Indeed, scholars investigating ATS employees' trust in automation found that too much trust may lead to overreliance or a reduced vigilance (Corver & Aneziris, 2015). This may also hold true for too much trust in the supervisor.

Another finding was that all investigated leadership aspects are highly related with each other. This corresponds with empirical findings in the literature, reporting a high overlap, yet conceptual distinctiveness, between LMX and trust (Dirks & Ferrin, 2002), LMX and servant leadership (Liden et al., 2008), and servant leadership and trust (Schaubroeck et al., 2011). The relationships between these leadership aspects and supervisor support for safety have not been investigated in the literature so far. Our findings suggest that in ATC, not only the general leadership aspects LMX, servant leadership, and trustworthiness are interrelated, but that they are also strongly related to supervisor support for safety. The implication is that leadership would benefit from a holistic approach (Meuser et al., 2016) and that leaders need to excel at different fronts.

Similarly, the strong relationship, yet distinctiveness between ATS employees' safety compliance and safety citizenship behavior corresponds with earlier empirical evidence of a strong association between both safety behaviors in other industries (Clarke, 2012). Thus, in ATC, too, safety compliance and safety citizenship behavior should be distinguished as two related, but discrete behaviors. Another reason to differentiate between both is that trustworthiness seems to be related to one but not both of the behaviors. This suggests that different relationships with leadership are in place for safety compliance and safety citizenship behavior.

ATS employees' safety behavior is not only important for the clear benefits of a safe airspace, but also for the performance of ANSPs, as safety and performance

are closely related in ATC (Griffin et al., 2000). This also informs the safety literature in such that safety behavior need not necessarily be adjacent to performance, but may also align with performance. Hence, the often-discussed discrepancy between safety behavior and performance (e.g., when safety features and material hinder performance) is not of importance in ATC. This would make the ATC environment an ideal research context because factors that predict safety will not be confounded with concerns for performance, because safe behavior is, in fact, performance. Even though perceptions of the discrepancy between safety and performance exist, research highlighted that even for industries that are usually thought of in terms of having a trade-off between safety and operations, safety also benefits operations and business performance (Veltri et al., 2013). This also opens the discussion in the safety literature as whether safety behavior and its predictors can be considered consistent with task performance predictions or with contextual performance. This would allow for further theorizing on safety behavior as task performance as opposed to safety behavior as contextual performance (that is, not essential for task performance). Research is needed to identify whether the mechanisms that operate for predicting safety are similar in contexts in which safety equates with task performance as compared to contexts in which safety is an additional requirement on top of performance.

Practical Implications

From a practical point of view, the current research aimed to contribute to our knowledge on which leadership aspects may be important for supervisors to ensure ATS employees' safety compliance and safety citizenship behavior. Some might argue that ATS employees do not need to enact safety citizenship behaviors because they behave completely safety compliant and this is what they need to focus on due to the urgent nature of their job. Indeed, air traffic controllers are less likely to enact contextual performance, under which safety citizenship behavior can be

categorized, in difficult situations due to urgent task demands (Griffin et al., 2000). Yet, both task and contextual performance contribute to ATS employees' perceived effectiveness (Griffin et al., 2000). A situation where the importance of safety citizenship behavior in ATC becomes very clear is the moment of position handover, when one ATS employee takes over from a colleague. In many ATS cultures and ANSPs from many different countries, there have been persistent problems associated with position handover, including omitting critical information leading to incidents shortly after. Even though conducting briefings during handover is expected from ATS employees, putting extra effort into helping colleagues and following up that the handover was successful is regarded safety citizenship behavior.[8] Our data, moreover, shows that ATS employees enact safety citizenship behavior (to some extent) on a daily basis.

The negative relationship between supervisors' trustworthiness and ATS employees' safety citizenship behavior implies that one needs to look at supervisors' trustworthiness with caution. Although a closer additional examination of this relationship is warranted, ANSPs might want to take into account the difficulties associated with supervisors' trustworthiness. The proper conditions should be investigated and created, under which supervisors' trustworthiness may be positive for safety. Besides trustworthiness, a moderate amount of distrust leading to checking and monitoring others' behavior, may be needed to promote safety behavior (Conchie & Donald, 2008). Indeed, if too much trust impedes acting or providing information (i.e., safety behavior), it can have detrimental consequences, as has been shown in research on interactions in aircraft cockpits (Schöbel, 2009).

The fact that we did not find any evidence for a positive relationship between supervisors' leadership aspects and ATS employees' safety behavior might lead to

[8] We thank an anonymous reviewer for pointing this out.

the conclusion that ANSPs may better focus on aspects other than leadership if wanting to increase ATS employees' safety behavior. However, as the results may have occurred due to the low power, it is still noteworthy to look at how supervisors could be supported to enact leadership behaviors that may be supportive for safety. Moreover, if it is true that there is currently no relationship between supervisors' leadership and employees' safety behavior, the question may be raised whether and how such a relationship should be established. Indeed, during the interviews, some ATS employees mentioned that it is not the role of supervisors to be their "leader". For example, feedback from their supervisor was said to be little valuable as supervisors would not have a good view on ATS employees' behavior and they would not always have the knowledge of the needed behavior. Yet, in other industries, providing feedback is a crucial task of supervisors, increasing employees' performance and safety behavior (Zohar & Luria, 2003). In our sample, ATS supervisors have many operational and organizing tasks, such as deciding about the correct runway or contacting backup-employees in case of illnesses. However, their job descriptions and training currently scarcely include leadership aspects. This aligns with the current attitude ATS employees have towards supervisors, as supervisors do not add much in terms of leadership, notwithstanding that ATS employees favor a servant leadership style. This would indicate that supervisors currently are withheld from fully engaging as leaders and take up the full range of leadership behaviors that are able to positively encourage ATS employees' safety behavior.

To date, empirical evidence concerning antecedents of leadership characteristics that are related to employees' safety behavior remains scarce (Conchie et al., 2013). Conchie and colleagues (2013) conducted focus groups with construction supervisors and found that social support and autonomy concerning leadership seem to be the most important factors helping supervisors in enacting

safety-effective leadership. The authors recommend supportive environments or "providing training that equips supervisors with the necessary interpersonal skills in how to approach employees about safety". The suggestions on how to support ATS supervisors that came up during the interviews may indicate additional pathways to stimulate safety-effective leadership. First, organizing adequate training and/or coaching for ATS supervisors may be relevant. This is supported by the findings of Conchie et al. (2013) in the construction industry, where supervisors indicated that their engagement in safety leadership was promoted when being equipped with the necessary knowledge, skills, and tools. Moreover, leadership interventions have proven their effectiveness in the safety literature, as leadership interventions have successfully improved supervisors' leadership and employees' safety behavior (Gravina et al., 2019; Kelloway & Barling, 2010). Second, it may be important to increase ATS supervisors' role clarity and include leadership aspects to their role definition. Zohar and Luria (2003) found that adapting supervisors' role definition to include employees' safety behavior increased supervisors' safety-oriented interactions with employees and subsequently employees' safety behavior. Thus, improving supervisors' role clarity and adding leadership characteristics to it might support supervisors and ATS employees' safety behavior. Role clarity could, for example, be increased by clarifying job descriptions (Bowling et al., 2017).

When wanting to address supervisors' leadership aspects, it must be taken into account that supervisors think their leadership qualities are perceived as more favorably than they are actually perceived by ATS employees (Coetzee & Henning, 2019). Thus, supervisors' awareness concerning how they are perceived may need to be sharpened.

Limitations and Future Research

A main limitation of the current research is the low participation and high drop-off rate. Consequently, the results may be biased, as the statistical power

turned out to be low. Moreover, given the low sample size, the planned analyses could not be performed. By consequence, we used a cross-sectional design, which inherits the risk of common-method bias, as independent and dependent variables were measured in the same way and at the same moment and rated by the same individuals (Podsakoff et al., 2003). Therefore, additional research with a larger sample size and multiple methods and/or sources needs to be conducted. Moreover, experimental designs would be valuable, as our design does not allow for any causal inferences. As argued for above, future research may also study colleagues as alternative role models and social exchange partners in ATC.

Future research may also want to focus on the training period, in which more senior air traffic controllers, called on-the-job training instructors (OJTIs), oversee novice air traffic controllers, called on-the-job trainees (OJTs). It would be interesting to investigate the relationship between OJTIs and OJTs, as role modeling may be crucial in this relationship. As such, a trickle-down of servant role modeling may occur from supervisor to OJTI and subsequently from OJTI to OJT. Moreover, comparing the impact of supervisors versus OJTIs on OJTs' and other ATS employees' safety behavior would be relevant. Indeed, it may be that the importance of safety behaviors is especially addressed during the training period by OJTIs. Another valuable approach would be to take a step back and conduct more exploratory qualitative research on the topic. While we did conduct informal interviews with various employees, many of them working or having worked as ATS employees and/or supervisors, an extension of this research is needed. A possibility would be to conduct focus groups with ATS employees and supervisors to ask them how and why they think they could and do influence each other.[9]

Another limitation is that the current research was limited to one ANSP, restricting the generalizability of the findings to other contexts, including other

[9] We thank an anonymous reviewer for these valuable suggestion.

industries or cultures (Mirza & Isha, 2017). Yet, the advantage of performing the study in one ANSP only is an enhanced control of the context. Moreover, we controlled for the impact of the unit, because even in the same country, different ATC units can behave in markedly different ways. This was also mentioned during the interviews, as interviewees repeatedly emphasized the differences in leadership systems between units that may lead to diverging findings. Our sample was not large enough to conduct analyses separately for different units or leadership systems. Future research should differentiate between different supervisor systems and roles and, as such, take the context even more into account. Moreover, future research is needed to take into account cultural and/or regional differences, which may direct ATC employees' safety behavior. In particular, the relations between management and supervisors is culturally dependent (Dickson et al., 2012) and hence, more knowledge on how these cultural elements play in ATC is highly relevant. Finally, as mentioned during the interviews, organizational factors may constraint ATS employees' safety behavior and/or supervisors' leadership, and should, therefore, also be taken into account in future research.

Additionally, factors that we did not investigate may influence the relationship between leadership and ATS employees' safety behavior. For example, Griffin and colleagues (2000) found indications that in difficult situations (among others in terms of traffic volume and complexity, weather conditions, and pilot actions), air traffic controllers are less likely to enact contextual performance due to urgent task demands. We did investigate the role of the shift as control variables as we expected situational difficulty in terms of traffic volume and complexity to vary systematically between the type of shift (week or weekend and early, intermediate, late, or night shift). However, factors such as weather conditions and pilot actions influencing the situational difficulty are largely independent of the type of the shift. Therefore, future research needs to consider the situational difficulty more directly.

Future research should also investigate how safety-effective leadership behaviors and characteristics may be supported. That research may build forth on our interview insights and investigate whether the training and/or coaching for (ATS) supervisors and/or increasing their role clarity may facilitate safety-effective leadership behaviors.

Finally, while we suggested and elaborated on theoretical mechanisms to explain the expected relationships between leadership and employees' safety behavior, we did not explicitly test those mechanisms. Additional research is needed that empirically tests for reciprocity and role modeling as mediating mechanisms. Similarly, while we tested the direct relationships between leadership aspects and safety behavior, we did not elaborate on the interrelations between the leadership aspects. Indeed, we found high correlations between the leadership aspects, which may indicate that they tend to co-occur, but also may indicate that some leadership aspects my explain others. For example, the constructive leadership style safety-related transformational leadership has been found to relate to safety citizenship behavior via trust in the leader (Conchie et al., 2012). Furthermore, high-quality LMX and trust have been shown to mediate the relationship between servant leadership and favorable employee behaviors (Van Dierendonck, 2011). In an ATC context, this needs further replication. Moreover, *safety-related* mediators would be interesting to investigate. In the literature, safety climate and employees' safety knowledge, motivation, and skills are often brought forward as mediators between leadership and employees' safety behavior (Christian et al., 2009; Clarke, 2013). As Hoffmeister and colleagues (2014) formulate it: "greater attention should be paid to the mechanisms by which leaders influence safety".

Conclusions

The current research aimed to understand the role of supervisors' leadership aspects in ATS employees' safety compliance and safety citizenship behavior. It

creates a foundation for further research in two ways. First, the conceptual model based on social learning theory, social exchange theory, and a consolidation of empirical findings forms a useful framework for further research. Second, the applied method and the research results form a starting point that invites researchers to further develop our knowledge on the role of supervisors' leadership in ATC. This is especially important as "the aviation industry is particularly unforgiving of safety limits" (Coetzee & Henning, 2019, p. 2).

Appendix 1: Method of Additional Data Collection

All air traffic controllers, on-the-job-trainees, and supervisors of a European ANSP (the same as where the current data collection was conducted) were invited to participate in a survey study at the end of a training session. Out of 233 employees, 228 participated, which corresponds to a response rate of 97.9%. One participant was excluded from the analyses, because the participant felt the questions did not relate to the specific job tasks.

All items were rated on a scale from 1 (*strongly disagree / never*) to 7 (*strongly agree / always*). Servant leadership of top management was measured using the seven-item short form of the servant leadership measure (Liden et al., 2008). The dimension "creating value for the community" was excluded as it was deemed irrelevant for the context, such that six items remained. To tailor the items to the context, the word "manager" was replaced by "management". An example item is: "I would seek help from my management if I had a personal problem". The scale's Cronbach alpha is .79.

To measure trust in management, a ten-item scale of Mayer and Gavin (2005) was used, of which an example item is "I would be willing to let my management have complete control over my future in this company". Cronbach's alpha for that scale is .69.

Fatigue was measured with a eleven-item scale of Van Yperen and Janssen (2002). "Working day" was replaced by "shift" and an example item is: "I find it difficult to relax at the end of a shift". The scale's Cronbach alpha is .91.

Chapter 3:

The Relationship Between Leadership and Employees' Cognitive Resources[10]

[10] This chapter has been submitted for publication in Journal of Applied Social Psychology: Schopf, A. K., Heine, C. E., Rahaman, S. H M, Cosemans, H., Stouten, J. (2021). *The relationship between leadership and employees' cognitive resources* [Manuscript submitted for publication]. Occupational & Organisational Psychology and Professional Learning research unit, KU Leuven.

A former version of this chapter has been presented: Schopf, Anna Katharina (2018, November). *The relationship between (transformational and transactional) leadership and employees' cognitive processes*. Paper presented at the WAOP (Werkgemeenschap van onderzoekers in de Arbeids- en Organisatiepsychologie) conference 2018, Leuven, Belgium.

Abstract

Drawing on the conservation of resources (COR) theory, this paper aims to examine the relationship between on the one hand transformational and transactional leadership and on the other hand employees' cognitive task performance. A sample of 99 employees from two Western-European organizations assessed their supervisors' leadership styles with the Multifactor Leadership Questionnaire and completed cognitive tasks aimed to measure attention, working memory, and problem-solving performance. Multiple regression and logistic regression analyses were conducted to test the relationships between leadership and cognitive task performance. Additional analyses were conducted to investigate a possible interaction between transformational and transactional leadership. Overall, no significant relations of either transformational or transactional leadership on employees' cognitive task performance were found. One significant interaction was revealed, indicating that the relationship between transactional leadership and employees' problem-solving was only significantly positive when levels of transformational leadership were low. The findings reveal that the relationship between (transformational and transactional) leadership and employees' cognitive task performance might be rather negligible and COR theory might not be largely able to explain this relationship.

Keywords: conservation of resources theory, transformational leadership, transactional leadership, cognitive resources, cognitive performance

Introduction

"A primary responsibility of leaders is to provide resources (e.g., emotional support, functioning equipment, clear communication, and flexible work hours) so that employees can successfully complete work" (Perry et al., 2010, p. 1146). In line with that statement, leadership research has examined different types of resources provided by leaders (such as self-esteem or career opportunities; e.g., Harris et al., 2011; Xu et al., 2015) drawing on conservation of resources (COR) theory (Hobfoll, 1989). The central tenet of COR is that individuals strive for resource surpluses (by obtaining, retaining, fostering, and protecting them), as resource loss or deficiency causes stress (Hobfoll et al., 2018). Resources can be defined as "those entities that either are centrally valued in their own right (e.g., self-esteem, close attachments, health, and inner peace) or act as a means to obtain centrally valued ends (e.g., money, social support, and credit)" (Hobfoll, 2002, p. 302). Leadership is able to provide resources and according to COR theory, resource gains lead to resource investment and accumulation (Hobfoll et al., 2018).

Only recently, theorizing and empirical studies concerning leadership and employees' resources, drawing on COR theory, have been undertaken. The extant research mainly focuses on employees' emotional or wellbeing states associated with leadership's resource provision or depletion (Hobfoll et al., 2018). Yet, leaders' resource provision may translate to other employee outcomes, such as cognitive resources and performance (Hobfoll et al., 2018). Examining whether this is the case is important in order to advance theorizing. Specifically, applying COR theory to formulate hypotheses concerning the relationship between leadership and employees' cognitive resources and then testing this relationship empirically may advance COR theory. Indeed, it may enable us to examine the applicability of COR theory to the provision of cognitive resources by leadership. Additionally, it is relevant to know whether leadership is able to relate to cognitive resources of

employees as cognitive resources are crucial for employee performance (Chan et al., 2018).

Moreover, the investigation of the relationship between leadership and employees' cognitive resources, measured by their cognitive task performance, is needed because leadership research to date mainly focusses on leadership associated with employees' motivation (Judge & Piccolo, 2004), neglecting employees' cognitive performance. More generally, Chan and colleagues (2018) note that "organizational behavior research has largely neglected an executive functioning lens" (p. 1), referring to a cognitive performance perspective. The present research, therefore, assesses whether leadership relates to employees' cognitive performance, indicating a surplus in cognitive resources.

Leadership has a strong potential to affect employees' resources, as leaders influence broader perceptions about the working environment as a whole (Hiller et al., 2011). According to COR theory, too, leadership may withhold or provide resource to employees (Halbesleben, 2006; Hobfoll et al., 2018). The current research focuses on transformational and transactional leadership, as the most widely studied leadership styles, which are especially prone to provide resources due to their unique characteristics. Transformational leadership provides a vision, inspiration, and motivation (Bass, 1999), and consequently is expected to accumulate employees' amount of resources (Hildenbrand et al., 2018; Walsh et al., 2014). Transactional leadership provides feedback and (contingent) rewards as resources (Judge & Piccolo, 2004). That way, it may increase employees' amount of resources. Both leadership styles have empirically been found to relate to employee outcomes (e.g., Inceoglu et al., 2018; Judge & Piccolo, 2004; Lowe et al., 1996; Wang et al., 2011). Additionally, by investigating transformational and transactional leadership, we avoid the current focus on abusive leadership and resource loss in

the leadership literature drawing on COR theory (Hobfoll, 2011; Hobfoll et al., 2018).

Concerning cognitive performance, which indicates the availability of cognitive resources, the current study focuses on three of the most essential cognitive resources for performance, that are, attention, working memory, and problem-solving. These are essential for employee performance especially when employees are required to behave and think quickly and adaptively, or when new job demands occur and time pressure exists (Chan et al., 2018), which is true for many of today's jobs. For example, during negotiations, employees need to pay attention to the perspective and actions of the other party, inhibit inappropriate statements, take the other party's perspective, and solve problems, all of which require cognitive performance in terms of attention, working memory, and problem-solving. According to COR theory, resources are accumulated and translated to other resources (Hobfoll et al., 2018). In line with that, we argue that the resources that leaders provide should also translate to cognitive resources and thus cognitive performance.

To summarize, drawing on COR, constructive leadership and in particular transformational and transactional leadership would positively relate to employees' cognitive resources in terms of attention, working memory, and problem-solving performances. The current study contributes to COR theory by specifically examining the theory's assumptions on cognitive resources in the context of leadership. Moreover, it advances the transformational and transactional leadership theories by investigating cognitive resource provision as an explanation for their positive effects on employees' performance. The current study also contributes to the leadership literature by expanding the focus to cognitive outcomes, aimed to complement motivational outcomes, which already received considerable empirical examination (Judge & Piccolo, 2004). This would further strengthen the theoretical

relevance of COR for the leadership literature, as there would be evidence for cognitive resource accumulation as a result of leaders' resource provision. As cognitive processes have been linked to employee performance (Bosco et al., 2015; Chan et al., 2018), our research is also of practical relevance for companies' leadership policies.

The hypotheses are tested by a survey design and by measuring the performance of employees of two Western-European organizations on attention, working memory, and problem-solving tasks. By using objective measures (cognitive task performance), we circumvent some of the existing problems with studies solely based on self-report measures (Antonakis, 2017; Podsakoff & Organ, 1986), and assess more implicit and unconscious effects of leadership (Johnson & Steinman, 2009).

Theory and Hypotheses

Theoretical Framework and Application to Our Research

COR theory (Hobfoll, 1989), initially developed as a stress model, has been applied beyond stress to organizational attitudes, behavior, and outcomes like motivation, emotional exhaustion, leadership, job performance, and turnover. Relatedly, the theory has established its role as one of the most widely recognized and cited theories in organizational behavior and psychology research (Halbesleben et al., 2014; Hobfoll et al., 2018). Hobfoll (1989) distinguishes between four categories of resources: object resources (e.g., company car), conditions (e.g., employment and tenure), personal characteristics supporting stress resistance (e.g., skills and self-esteem), and energy resources (e.g., knowledge and money). One of the theory's principles is that individuals invest resources to retain resources, prevent resource loss, and gain more resources (i.e., resource investment principle). Especially in case of resource surpluses, individuals are able to invest resources to gain additional resources, thereby evoking resource gain spirals. When experiencing

resource depletion, however, individuals experience stress and do not have the necessary resources to invest and prevent further resource loss. Consequently, resource loss spirals occur (Hobfoll et al., 2018).

While Hobfoll (1989) does not include leadership directly, he mentions social relationships in general, and theorizes that they "are seen as a resource to the extent that they provide or facilitate the preservation of valued resources, but they also can detract from individuals' resources" (p. 517). Generally, Hobfoll (1998) found 74 resources, valid in Western cultures, of which some can be expected to be influenced by leadership, like "help with tasks at work", "acknowledgement of my accomplishments", and "understanding from my employer/boss" (see also Halbesleben, 2006). Other resources might be more indirectly affected by leadership, such as "feeling that I am successful", and "feeling that I am accomplishing my goals". Halbesleben (2006) too, argues that leaders are in a position to impact work-related resources. As Inceoglu and colleagues (2018) put it, "leaders can enable resources […] by shaping the work environment through opportunities for rewards, autonomy, skill discretion and being a source of social support themselves" (p. 181).

Empirical Findings Concerning Leadership and COR Theory

COR has recently been studied extensively in the leadership literature (Hildenbrand et al., 2018), even though this research predominantly measured employees' resources in terms of emotional or wellbeing states. For example, scholars investigated the role of destructive leadership styles, such as abusive supervision, in the depletion of employees' resources (e.g., Carnevale et al., 2018; Lee et al., 2018; Xu et al., 2015). They hypothesized that destructive leadership leads to employees' resource depletion by the threat of or actual loss of resources linked to COR conditions (e.g., career opportunities; Xu, et al., 2015) or personal characteristics (e.g., sense of personal control; Lee, et al., 2018). The resource

depletion has often been operationalized as emotional exhaustion, and further hypothesized to have adverse effects, such as decreased voice behavior and knowledge sharing (e.g., Carnevale et al., 2018; Lee et al., 2018). These adverse effects have been argued to occur due to stress and employees' focus on resource conservation because of resource depletion.

The role of constructive leadership styles, for example goal-focused, ethical, and transformational leadership, in relation to COR theory has also been investigated (e.g., Hildenbrand et al., 2018; Kalshoven & Boon, 2012; Perry et al., 2010). Often, the authors argued that constructive leadership provides resources to employees linked to COR conditions (e.g., support of work-family integration; Braun & Peus, 2018), personal characteristics (e.g., self-esteem; Harris et al., 2011), and energies (e.g., knowledge; Harris et al., 2011). These resources in turn increase employees' wellbeing and health (e.g., Perry et al., 2010; Walsh et al., 2014), and are eventually invested by employees in the form of favorable behaviors, like helping others (Kalshoven & Boon, 2012). The hypothesized relationships have generally been supported. Additionally, meta-analytic research confirmed a positive relationship between supervisor support and burnout, as predicted by COR theory (Halbesleben, 2006).

In conclusion, studies applying COR theory to leadership usually investigate leadership's relationship to employees' resources, measuring them as emotional or wellbeing states, and eventually employees' behavior. However, whether leadership also relates to employees' cognitive resources has yet to be investigated (Hobfoll, 1989). Carnevale and colleagues (2018) are the only ones to our knowledge who have investigated the influence of leadership on cognitive resources drawing on COR theory. They argued that leadership affects employees' affective and cognitive resources and found evidence for their proposed relationship between narcissistic leadership and employees' voice behavior, mediated by decreased work energy, a

concept combining affective, cognitive, and behavioral arousal (Carnevale et al., 2018). However, as they tested the whole construct of work energy at once, they were not able to draw conclusions on cognitive resources specifically. Moreover, they focused on narcissistic leadership and little is known on the most widely researched leadership theories of transformational and transactional leadership. Hence, the current study turns to more objective measures of cognitive resources and focuses on transformational and transactional leadership.

Transformational and Transactional Leadership

Drawing on the full-range leadership model (Avolio, 1999), transformational and transactional leadership can be distinguished as different but not mutually exclusive leadership styles. Transformational leadership is characterized by offering purpose and focusing on higher order needs, and has consistently been shown to relate to favorable outcomes such as employee wellbeing, job satisfaction, motivation, and performance (e.g., Arnold, 2017; Dumdum et al., 2013; Judge & Piccolo, 2004; Wang et al., 2011). This relationship seems to be mediated by different aspects, such as meaningfulness, work characteristics, and self-efficacy (Walsh et al., 2014). Researchers have recently explained the mediated relationships by referring to COR theory. According to this perspective, transformational leadership provides resources to employees, for example by providing meaning, empowerment, intellectual stimulation, vision, and role clarity. In turn, these resources enable employees to invest and further expand their resources, leading to a resource gain spiral (Hildenbrand et al., 2018; Walsh et al., 2014). An increased wellbeing (Walsh et al., 2014) and a decreased experience of burn-out (Hildenbrand et al., 2018) have been found outcomes of this resource gain spiral evoked by transformational leadership.

Transactional leadership is characterized by an exchange relationship between leader and employees, and has also been shown to have a favorable

influence on employee outcomes such as employee job satisfaction, motivation, and performance (e.g., Judge & Piccolo, 2004; Lowe et al., 1996). Similar to transformational leadership, the favorable influence of transactional leadership can be argued to stem from resource provision. Transactional leaders perform activities as planning, assigning tasks, evaluating performance, giving feedback, and allocating rewards (Judge & Piccolo, 2004). Consequently, they are likely to deliver resources as knowledge, role clarity, and money. Summing up, transformational and transactional leadership are well-established leadership styles in the literature, which have been shown to have favorable outcomes and are expected to provide resources to employees due to their characteristics.

Cognitive Processes and Hypotheses Development

This study relies on objective measures of energy resources based on cognitive processes. Attention, working memory, and problem-solving are included, which are major cognitive processes and fall under the notion of *executive functions* (Chan et al., 2008). Executive functions are "a collection of top-down control processes used when going on automatic or relying on instinct or intuition would be ill-advised, insufficient, or impossible" (Diamond, 2013, p. 136). Executive functions predict job performance beyond intelligence (Chan et al., 2018). Attention, working memory, and problem-solving reflect cognitive resource usage, as shown by empirical studies using pupillary dilations as a psychophysiological index of cognitive resource usage (Karatekin et al., 2007). While individuals generally differ in their capacity to perform on attention, working memory and problem-solving tasks, also fluctuations within individuals exist (Chan et al., 2018; Diamond, 2013). Thus, individuals may be better or worse in cognitive performance, depending on the circumstances, enabling leaders to exert an influence on this performance.

Empirical evidence suggests that transformational leadership provides resources and thereby employees' emotional and wellbeing states are increased

(Hildenbrand et al., 2018; Perko et al., 2016; Walsh et al., 2014). We argue that, when drawing on COR theory, the provided resources should also lead to an increased cognitive performance due to resource accumulation. Moreover, similar arguments should apply for transactional leadership. Indeed, employees may reinvest resources received from leaders, as follows from the resource investment principle of COR theory. As the resource gain occurs at work, reinvestments are expected to happen at work as well (Halbesleben et al., 2009; Hobfoll, 2011). Investing cognitive resources to increase cognitive performance is a reasonable way to reinvest resources in the workplace.

The cognitive measures that are used are related to real-life behavior and performance, and as such, performance on the used tasks is relevant to the workplace. For example, performance on the task that is used to measure sustained attention (Sustained Attention Response Task, SART) has been found to relate to slips of behavior, perception, and memory functions in everyday life (Robertson et al., 1997). Slips such as failing to listen to people's names when meeting them and leaving important letters unanswered for days clearly also concern workplace performance (Broadbent et al., 1982).

Attention

We distinguish between selective and sustained attention. Selective attention refers to the inhibitory control of attention and thus focusing on a stimulus while suppressing one's attention for other stimuli (Diamond, 2013). On the other hand, sustained attention can be defined as "the ability to self-sustain mindful, conscious processing of stimuli whose repetitive, non-arousing qualities would otherwise lead to habituation and distraction to other stimuli" (Robertson et al., 1997, p. 747). Attention is thus needed to focus on relevant aspects (e.g., of a task) and to continue focusing on these.

Empirical evidence suggests that leaders' transparent behavior is related to employees' ability to focus attention (Yi et al., 2017). As transparent behavior of leaders refers to a leader-employee relationship characterized by information sharing, feedback and general openness (Yi et al., 2017), both transformational and transactional leadership imply this kind of behavior and are expected to relate to attentional processes.

By articulating a clear, encouraging, and inspiring vision (Judge & Piccolo, 2004), the transformational leader highlights important organizational goals and directs the attention of employees towards accomplishments of these goals and relevant stimuli and activities. Similarly, the transformational leader is assumed to decrease the appeal of and distraction from other competing goals and stimuli. Transactional leaders, too, clarify expectations and reward employees accordingly (Judge & Piccolo, 2004), thereby directing employees' attention towards relevant goals and stimuli. Additionally, transactional leaders direct employees' attention when necessary by taking corrective action (Judge & Piccolo, 2004).

From a COR theory perspective, the mentioned behaviors of transformational and transactional leaders can be regarded as resources for employees that may enable them to maximize their selective and sustained attention. Taken together, we formulate:

Hypothesis 1a. Transformational leadership is positively related to performance on attention tasks.

Hypothesis 1b. Transactional leadership is positively related to performance on attention tasks.

Working Memory

Working memory involves "holding information in mind and mentally working with it" (Diamond, 2013, p. 142). It is vital for any job, as it is important for cognitive activities such as reasoning, critical thinking, decision making,

negotiating, or organizing task priorities (Chan et al., 2018; Diamond, 2013; Redick & Lindsey, 2013).

Working memory performance can be influenced by sleep deprivation, fatigue, stress, affect, cognitive load, negative thoughts, or ruminations (Ilkowska & Engle, 2010). From a COR theory perspective, transformational and transactional leadership are expected to have a positive influence on these aspects by resource provision. Empirically, transformational leadership has been found to relate positively to employees' sleep quality over time (Munir & Nielsen, 2009) and positive affect (Bono et al., 2007), and negatively to stress symptoms (Arnold, 2017) and work-related rumination (Perko et al., 2014). Evidence suggests that these relationship are indirect, mediated by provided resources such as meaningful work or self-efficacy (Arnold, 2017). There is less research concerning these factors and transactional leadership. One exception is that transactional leadership has been found to relate negatively to stress (Skakon et al., 2010). We argue that the clear guidance by means of rewards, punishment, monitoring, and intervention might free cognitive resources of the employees, freeing an increased working memory capacity.

Research also reveals that feedback positively affects working memory. In a study concerning memory boosting in children, Boland and colleagues (2003) reported that the event memory of children was enhanced after implementing techniques such as giving positive feedback and asking "why"-questions. The transformational leader provides each employee with qualitative monitoring and feedback by means of individual consideration. The transactional leader, too, gives feedback by means of rewards (Judge & Piccolo, 2004). Accordingly, we hypothesize:

Hypothesis 2a. Transformational leadership is positively related to performance on working memory tasks.

Hypothesis 2b. Transactional leadership is positively related to performance on working memory tasks.

Problem-Solving

Problem-solving entails translating a problem statement into an internal representation, selecting and applying a method to solve the problem and, if it fails, trying another method or changing the internal representation (Newell & Simon, 1972). By identifying problems and finding a solution for it, problem-solving combines existing knowledge in a unique manner, thereby creating new knowledge. Knowledge (creation) in turn is crucial for organizations' efficiency and productivity (Nickerson & Zenger, 2004). Moreover, solving occurring problems at the workplace is an important employee behavior by itself (Chan et al., 2018).

The transformational leadership dimension of intellectual stimulation explicitly emphasizes problem-solving (Lowe et al., 1996). Jung (2001) stated that, through intellectual stimulation, transformational leaders promote (creative) problem-solving performance by encouraging "out-of-the-box"-thinking. He (Jung, 2001) and other researchers (e.g., Carmeli et al., 2014) found empirical evidence for a positive relationship between transformational leadership and problem-solving. As Lowe and colleagues (1996) put it: "The transformational leader [...] may provide a new strategy or vision to structure the way to tackle a problem, endowing the subordinate's sovereignty in problem-solving" (p. 387). Providing strategies and visions can be seen as providing resources through a COR theory lens. Those resources are expected to translate into an increased possibility to invest resources, for example in terms of an enhanced problem-solving performance.

One characteristic of transactional leadership is to anticipate problems (Judge & Piccolo, 2004). This can be expected to relate to employees' problem-solving performance by making them aware of, and maybe discussing, anticipated problems. Moreover, transactional leaders intervene when problems occur and help

solving them (Judge & Piccolo, 2004). Indeed, Daniels and colleagues (2013) found that discussing problems with others to solve them increases effective problem-solving. Finally, transactional leadership may engender problem-solving by emphasizing the benefits of solving work challenges. Applying COR theory, making employees aware of problems, discussing them, intervening, and helping to solve them may be categorized as resources, which on their turn may increase employees' problem-solving performance. Taken together, we formulate:

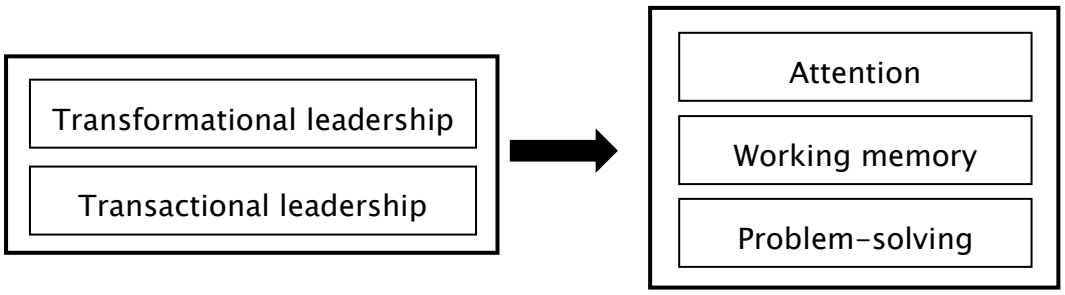
Hypothesis 3a. Transformational leadership is positively related to performance on problem-solving tasks.

Hypothesis 3b. Transactional leadership is positively related to performance on problem-solving tasks.

The conceptual research model is depicted in Figure 3.1.

Figure 3.1

Conceptual Research Model



Method

Data was collected with a) quantitative questionnaires assessing control variables and supervisors' leadership styles, and b) performance tasks measuring employees' attention, working memory, and problem-solving performance.

Participants and Procedure

Employees of two Belgian organizations participated in the study. While an email-invitation to participate in the study was sent to 360 employees, 99

employees took part in the study, yielding a response rate of 27.5%. Employees of Organization 1 (n = 51) worked at the IT-department of a utilities company, whereas employees of Organization 2 (n = 48) worked in various departments of a government agency. Two respondents from Organization 2 were excluded from the analyses, as they were cleaning staff and not directly affiliated to the organization. The study took one hour for participants to complete, and was conducted during employees' working hours at the organizations' sites, in rooms separate from employees' work desks. While employees of Organization 2 completed the study with five fixed computers, employees of Organization 1 brought their own laptop.

The majority of the participants were male (54.6%); the mean age was 44.59 years (SD = 10.65). As their highest obtained degree, most participants indicated secondary education (40.2%), while 33.0% indicated a university degree, and 26.8% a higher professional degree as their highest obtained degree. On average, participants had worked for 15.69 years (SD = 12.48) at their current organization, and 6.84 years (SD = 10.17) under their current supervisor.

The questionnaire regarding demographics and supervisor's leadership styles, and the Cognitive Reflection Test (CRT) were presented as online questionnaires. All other cognitive tasks were provided using Affect (Spruyt et al., 2010) in the following order: the Two String Problem, an Automated version of the Operation Span task (Aospan), the SART, Duncker's Candle Problem, and the Stroop task. The study was conducted in Dutch or French, depending on the participant's native language.

Measures

Transactional and Transformational Leadership

The Multifactor Leadership Questionnaire (MLQ) was employed to assess perceptions of transformational and transactional leadership styles (Bass & Avolio, 1995). Employees were asked to indicate how often their leader displayed certain

behaviors, such as "he/she makes me feel enthusiastic about the assignments that need to be accomplished" (transformational leadership) or "he/she rewards me according to the support I give him" (transactional leadership). All items were scored using a 7-point Likert scale ranging from *never* (1) to *always* (7). A 60-item Dutch translation of the MLQ was used, adapted from Schutte (2010). The French version consisted of a translation of the Dutch version, performed by Dutch and French native speakers in joint deliberation. Cronbach's alphas of .96 (Dutch version) and .98 (French version) for transformational leadership, and Cronbach's alphas of .84 (Dutch version) and .81 (French version) for transactional leadership showed good internal reliabilities.

Problem-Solving

Problem-solving was assessed by the CRT, the Duncker's Candle Problem, and the Two String Problem. The CRT entails numerical problems, which evoke an intuitive but wrong answer, and a correct answer, for which deliberate thinking is needed. An example item is: "A bat and a ball cost $1.10 in total. The bat costs a dollar more than the ball. How much does the ball cost? _____ cents" (correct answer = 5 cents, intuitive answer = 10 cents; Frederick, 2005). An extended seven item form of the CRT was used, created by Toplak and colleagues (2014) by adding four items to the original test. The current sample confirmed the reliability of this measure (α = .81). There was no time restriction and the total of correctly answered problems was used as task performance.

Both the Duncker's Candle Problem (Duncker, 1945) and the Two String Problem (Maier, 1931) are often used insight problem-solving tasks in which participants must think of alternative functions of objects (i.e., overcoming functional fixedness) to find the solution (Davis, 2009). In the Duncker's Candle Problem, participants had to find a way to attach a candle to a wall such that it would burn without dropping wax on the floor. They could use several objects, such

as matches and thumbtacks. In the Two String Problem, participants had to help an imaginary person attach two ropes while the distance between the ropes was longer than the person's arm span. A toolbox was available, containing materials such as a ruler, a hammer, and screwdrivers. For both problems, a written description and a clarifying picture were presented for 20 seconds. Afterwards, participants had five minutes to enter their solution while the essence of the problem was still presented. At the end of each task, two scores for each task were collected: whether the participant found the right solution (yes/no) and time needed. Performance was measured as either correct or incorrect, controlling for the time needed. Before the tasks, participants were also asked whether they were already familiar with the Duncker's Candle Problem and/or the Two String Problem (yes/no).

Attention

Attention was measured with two different tasks. The SART is a test of sustained attention, while the Stroop task measures selective attention, or executive inhibition (Marcusson-Clavertz et al., 2016). The validity and reliability of both tasks have been demonstrated (Macleod, 1991; Robertson et al., 1997). During the SART (Robertson et al., 1997), participants received a set of digits (from 1 to 9; in font Arial, size 48, color white) in the center of a black screen, separately for 250 milliseconds each. Participants were instructed to press the space bar when a digit appeared, unless the number was '3' (target). They had 1000 milliseconds to press the space bar before the next digit appeared, but were instructed to execute the task as quickly and accurately as possible. 20 exercise trials, including four target-trials and providing accuracy feedback, preceded the measurement. The real task consisted of 252 trials, with 10% target- and 90% non-target-trials. Each number appeared in a random order for an equal amount of times and no feedback was given. The task lasted for approximately five minutes, during which no break was provided. Two scores were collected: the accuracy with a total of 252 and the mean

reaction time. Reaction time was chosen as the measure of performance, controlling for the participant's accuracy during all analyses, as has been argued for by Seli and colleagues (2013).

The Stroop task was modeled on Stroop (1935). Participants were shown a series of visual stimuli consisting of inked color words ('blue', 'yellow', 'red', 'orange', 'green'). The task was to identify, as quickly and accurately as possible, in which ink the word was written. In congruent trials, the ink matched the written word (e.g., the word 'blue' written in blue), in incongruent trials not. Each trial started with a white fixation cross in the center of a black screen for 500 milliseconds. After another 200 milliseconds of a plain black screen, a target stimulus (font Arial, size 24) was presented at the same position. Beneath, five color buttons allowed participants to indicate their response. After 1300 milliseconds, the stimulus disappeared, and the next trial started. The measurement was preceded by 25 exercise trials with accuracy feedback. The real test consisted of four blocks of 25 trials each (5 congruent trials and 20 incongruent trials) and lasted approximately 3.5 minutes. Within each block, all trials appeared in a random order. No feedback was offered, and participants could take breaks between the blocks if they wished. The accuracy with a total of 100 and the mean reaction time were collected. The reaction time was used as outcome measure while controlling for the accuracy, to make the outcome congruent to the SART measurement. Participants were also asked whether they were colorblind (yes/no).

Working Memory

The Aospan (Unsworth et al., 2005) measured participants' working memory performance. Its validity and reliability have been confirmed by Unsworth et al. (2005). The task required participants to remember a set of digits while solving a series of basic math equations. Participants were first presented with a digit ranging from one to nine (font Arial, size 48) at the center of the screen for 800

milliseconds. Immediately thereafter, a math equation (e.g., (4x3) – 4 = 8) appeared, for which they had to indicate whether it was true or false. Participants were instructed to solve the equation as quickly as possible, with no time limit. After two to seven sets of alternating digits and math equations, participants were asked to input the series of digits in the correct order. Two exercise trials with a set size of two were provided including accuracy feedback. In the real test, two trials of each set size (two to seven digits and math equations) were presented in ascending order. An accuracy score was collected, which was the total amount of digit series the participant could recall correctly with a maximum of twelve, and the time needed to check the math equations. The task took approximately five minutes to complete. Accuracy of the digit series recall was chosen as performance measure. Additionally, an 85% math equation accuracy criterion was imposed, to exclude participants who did not correctly solve at least 85% of the equations, as has been argued by the original article (Unsworth et al., 2005).

Control Variables

Previous research has shown associations between cognitive performance and/or perceived leadership with other variables. First, indications of relationships between the performance and malleability of several cognitive processes and the demographic variables sex, age, and educational level exist (e.g., Ellis, 2011; Herrera-Guzmán et al., 2004; Kousaie et al., 2014; Singer et al., 2003). Additionally, data has been collected at two organizations, and organization has been found to moderate the relationship between leadership behavior and employee performance (Li et al., 2013). Moreover, the duration of the supervisor-subordinate relationship (supervisor tenure) might influence the perceived extent of resource provision (Fagenson-Eland et al., 1997) and the supervisor-subordinate relationship more generally (Martinez et al., 2012). Finally, organizational tenure may influence the results. Consequently, the present study included demographics (i.e., age, gender,

and educational level), organization, supervisor tenure, and organizational tenure as control variables. All control variables were assessed with self-report questions. We tested for associations between the control variables and our study variables to assess whether they should be controlled for while testing our hypotheses.

Analytical Strategy

The data was analyzed using regression analyses and the PROCESS macro for SPSS (Hayes, 2017). Multiple regression analyses were conducted to test our hypothesized associations between leadership styles and employee performance on cognitive tasks. Logistic regression analyses were used to test our hypotheses regarding the Duncker's Candle Problem task and the Two String Problem task. Additional analyses were conducted to test for moderating effects of both leadership styles on employee performance. This technique uses bootstrapping, which entails treating the sample as if it was a population and resampling with replacement for 5000 times. It does not require the data to be normally distributed and computes confidence intervals (Hayes, 2017). We applied the approach of Becker (2005) and report the results with only those control variables that affected the results.

Results

Table 3.1 presents the means, standard deviations and intercorrelations of the study and control variables. Table 3.2 presents the unstandardized regression coefficients of the predictors on the dependent variables. Age, organization, and organizational tenure affected the results of all analyses and were thus generally included. Educational level only affected the results of the Stroop and Aospan analyses and supervisor tenure only affected the results of the Stroop analysis. Therefore, educational level and supervisor tenure were only included in the

analyses where they mattered. Finally, gender did not affect any of the analyses and the results are thus reported without this control variable (Becker, 2005).

Table 3.1

Means, Standard Deviations, and Intercorrelations of Study Variables

	Mean	*SD*	1	2	3	4	5	6	7	8	9
1. Age	44.59	10.65									
2. Educational level	2.93	0.86	−.40***								
3. Supervisor tenure	6.84	10.17	.47***	−.49***							
4. Organizational tenure	15.69	12.48	.74***	−.69***	.63***						
5. Transformational Leadership	4.34	0.96	−.28**	.15	−.11	−.22*					
6. Transactional Leadership	4.29	0.74	−.10	.12	−.03	−.15	.78***				
7. CRT accuracy	3.48	2.33	−.35**	.50***	−.49***	−.48***	0	.07			
8. SART reaction time (ms)	377.10	73.78	.18	.18	−.01	−.05	−.15	−.06	−.07		
9. Stroop reaction time (ms)	1058.00	124.55	.55***	−.41***	.44***	.52***	−.24**	−.17	−.31**	.17	
10. Aospan accuracy (%)	92.84	7.36	−.04	.25*	−.27*	−.16	.02	.09	.34**	.13	−.25*

Note. $N = 97$.

*$p < .05$, ** $p < .01$, ***$p < .001$.

Table 3.2

Unstandardized Regression Coefficients of Predictors on Dependent Variables

Predictors		Dependent Variables					
		CRT	Duncker's Candle	Two String Problem	SART	Stroop	Aospan
Age	*b*	−0.02	−0.07*	0.03	2.44**	2.47*	0.08
Educational level	*b*					13.03	−0.17
Organization	*b*	−1.71*	0.32	0.04	−3.78	8.50	−1.94
Supervisor tenure	*b*					−0.26	
Organizational tenure	*b*	−0.03	0.01	−0.10	−1.13	1.26	−0.08
Test-specific control	*b*		0.01	0.00	6.87	−3.38	0.00
Transformational Leadership	*b*	−0.67	−0.67	−0.14	6.69	−21.91	−0.50
Transactional Leadership	*b*	0.55	0.88	−0.36	−14.62	4.08	0.55
	F / *−2LL*	8.22***	103.27*	47.07	13.71***	38.14***	1.76
	R^2	.31	.23*	.15	.48	.79	.14

Note. N between 86 and 97.

In case of Duncker's Candle and Two String Problem, *−2LL* and Nagelkerke pseudo R^2 are reported (logistic regression analyses), in case of CRT, SART, Stroop, and Aospan, *F* and R^2 are reported (linear regression analyses). Control variables were only included if they affected the results; where no *b* is given, the control variable was not included in the analysis.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Main Analyses

Attention

Three participants indicated to be colorblind and were excluded from the Stroop analysis, resulting in 94 participants for this analysis. Results showed no significant associations between performance on the Stroop task and transformational leadership (b = -21.91, p = .07), and transactional leadership (b = 4.08, p = .78). Additionally, neither transformational leadership (b = -6.69, p = .52) nor transactional leadership (b = -14.62, p = .26) were associated with the SART performance. Hence, no support was found for Hypotheses 1a and 1b.

Working Memory

Neither transformational leadership (b = -0.50, p = .49) nor transactional leadership (b = 0.55, p = .55) were significantly associated with the Aospan performance. Thus, no support was found for Hypotheses 2a and 2b.

Problem-Solving

Only participants who were not familiar with Duncker's Candle Problem and the Two String Problem were selected in the hypotheses testing concerning these two problem-solving performances, resulting in 86 participants for these analyses. Neither transformational leadership (b = -0.67, p = .12) nor transactional leadership (b = 0.88, p = .10) were significantly associated with performance on the Duncker's Candle Problem. Results also showed that neither transformational leadership (b = -0.14, p = .82) nor transactional leadership (b = -0.36, p = .69) were significantly associated with performance on the Two String Problem. Additionally, no significant associations were found between CRT performance and transformational leadership (b = -0.67, p = .07), and transactional leadership (b = 0.55, p = .23). Therefore, there was no support found for Hypotheses 3a and 3b.

Additional Analyses

Given findings in the extant literature that transformational and transactional leadership interact concerning employee outcomes such as employee performance (e.g., Vecchio et al., 2008), additional analyses were conducted to test whether the levels of transformational leadership and transactional leadership interact concerning participants' cognitive task performances. Table 3.3 presents the unstandardized regression coefficients of the predictors, including the interaction term, on the dependent variables. No significant interaction effects were found of transformational leadership by transactional leadership on SART performance (b = 5.41, p = .35) or Stroop task performance (b = -4.73, p = .55). Similarly, no significant interaction effect was found of transformational leadership by transactional leadership on Aospan task performance (b = -0.46, p = .25), the Duncker's Candle Problem (b = 0.02, p = .94) or the Two String Problem (b = -0.09, p = .85).

Table 3.3

Unstandardized Regression Coefficients of Predictors, Including Interaction Term, on Dependent Variables

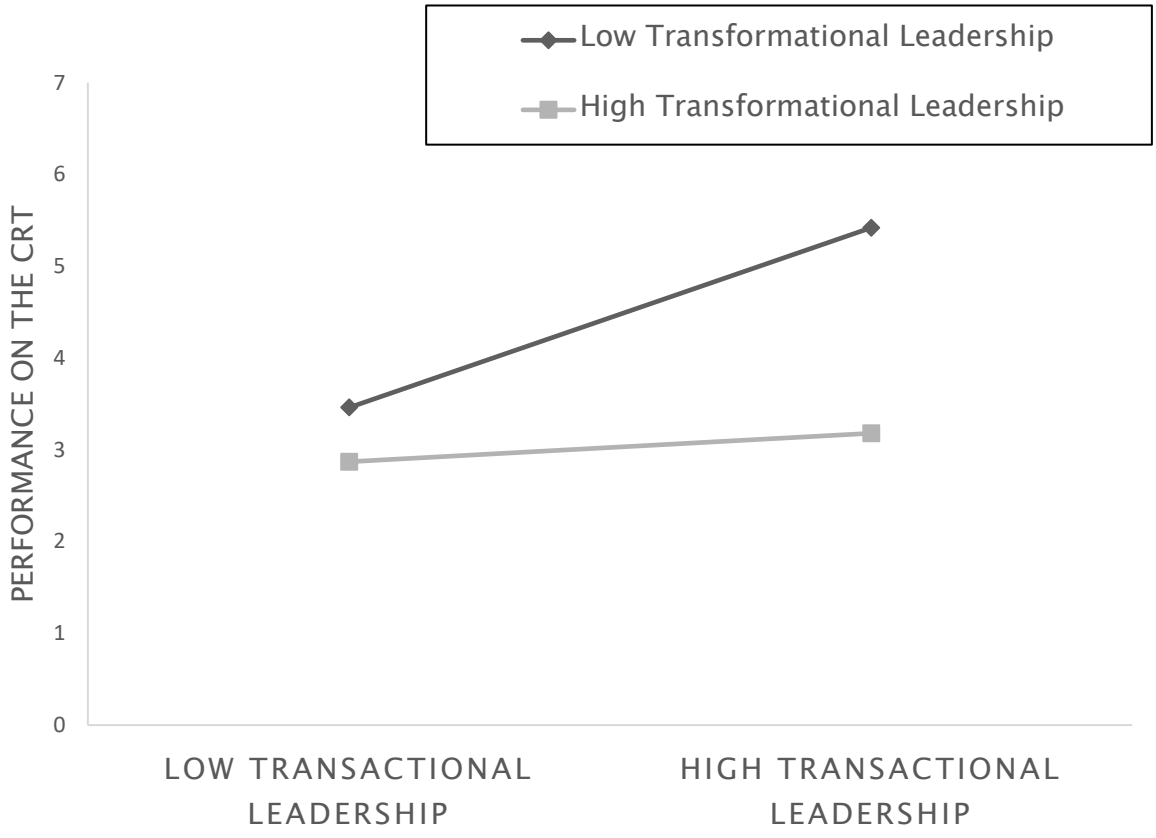
Predictors		Dependent Variables					
		CRT	Duncker's Candle	Two String Problem	SART	Stroop	Aospan
Age	*b*	−0.02	−0.07*	0.03	2.47**	2.45*	0.09
Educational level	*b*					13.15	−0.21
Organization	*b*	−1.80**	0.33	−0.00	−3.04	7.56	−2.06
Supervisor tenure	*b*					−0.18	
Organizational tenure	*b*	−0.02	0.01	−0.09	−1.27	1.33	−0.08
Test-specific control	*b*		0.01	0.00	6.75	−3.42	−0.00
Transformational leadership	*b*	1.78*	−0.74	0.23	−16.21	−1.31	1.42
Transactional leadership	*b*	3.39**	0.80	0.03	−40.42	26.89	2.74
T x T	*b*	−0.59**	0.02	−0.09	5.41	−4.73	−0.46
	F / *−2LL*	8.94***	103.27*	47.03	11.86***	33.68***	1.71
	R^2	.37***	.23*	.15	.48***	.79***	.16

Note. N between 86 and 97; T x T = Transformational leadership x Transactional leadership (interaction term).
In case of Duncker's Candle and Two String Problem, *−2LL* and Nagelkerke pseudo R^2 are reported (logistic regression analyses), in case of CRT, SART, Stroop, and Aospan, *F* and R^2 are reported (linear regression analyses). Control variables were only included if they affected the results; where no *b* is given, the control variable was not included in the analysis.
* $p < .05$, ** $p < .01$, *** $p < .001$.

A significant interaction was found of transactional leadership by transformational leadership on CRT performance (b = -0.59, p < .01). The association between transactional leadership and CRT performance was significant and positive when transformational leadership was low (b = 1.37, p < .01), but not when transformational leadership was high (b = 0.22, p = .63; Figure 3.2).

Figure 3.2

Graph of Interaction Effects of Transactional by Transformational Leadership on Performance on the CRT



Discussion

Relying on COR theory, leadership has been argued to provide important resources for employees. Even though the current literature has found support for the role of COR in leadership on different resources (such as self-esteem or career

opportunities; e.g., Harris et al., 2011; Xu et al., 2015) and has hinted for the role of leadership for employees' cognitive resources (Carnevale et al., 2018), we hypothesized and tested previously untested cognitive resources as an energy resource. In particular, we tested the relationships of transformational and transactional leadership with employees' cognitive performance in terms of attention, working memory, and problem-solving. We theorized that due to the unique characteristics of transformational and transactional leadership, employees might gain cognitive resources by virtue of these leadership styles, which in turn may relate to their cognitive performance. The results did not corroborate the theoretical reasoning and revealed no direct relationships of transformational and transactional leadership with employees' cognitive performances. However, additional analyses revealed the presence of a significant interaction effect of transactional by transformational leadership on employees' performance on one problem-solving task (i.e., the Cognitive Reflection Test, CRT). In particular, the relationship between transactional leadership and employees' ability to solve the problems presented in the CRT was only significantly positive when the levels of transformational leadership were low.

Theoretical Contributions and Practical Implications

The current study examines the claim in the literature that leadership provides resources to employees in the context of cognitive resources. We are unaware of any study that previously included employees' cognitive task performance while treating leadership as the provider of resources. We believe that the current findings have relevant theoretical implications for the application of COR theory in leadership research. Specifically, the findings indicate that the claim that leadership provides resources might not be as straightforward as originally thought by scholars when approaching cognitive resources. COR theory may still offer a valuable framework for understanding leadership and employee outcomes, as

previous research successfully confirmed leadership's provision of conditions, personal characteristics, and energy resources. Yet, in this study, leaders seem less able to stimulate employees' *cognitive* energy resources. This could mean that, to some degree, COR theory might not be largely applicable to explain the – direct – relationship between on the one hand transformational and transactional leadership styles and on the other hand employees' cognitive performance.

This is not the first study finding predictions based on COR theory's implications to be unsuccessful. For example, Halbesleben (2006) tested COR theory's implication that social support would be differentially related to the burnout dimensions and found no support for it in a general note. Differential relationships were only detected when taking into account the moderating role of the support source. It might be that part of the "implications for conservation and utilization of resources need to be more clearly defined" (Halbesleben, 2006, p. 1138). An explanation for the missing relationship between leadership and cognitive resources may lay in the notion that "social support can also be related to demands… as the nature of the social support may be a demand itself" (Halbesleben, 2006, p. 1140). Leadership may provide resources but at the same time also ask resources, for example by evoking employees' efforts.

While we did not find any significant relations of either transformational or transactional leadership on employees' cognitive task performances, we demonstrated a significant interaction between the two leadership styles in predicting employees' problem-solving performance. Specifically, we found that at a low level of transformational leadership, transactional leadership predicts higher levels of employees' problem-solving performance. Even though this interaction occurred in only one of the six tasks, this finding contributes to the literature of transformational and transactional leadership regarding employees' cognitive task performances. Extant research indeed argues and shows the presence of a negative

interaction between transformational and transactional leadership styles on employee job performance in general (Vecchio et al., 2008). In particular, Vecchio et al. (2008) found that leaders' vision and intellectual stimulation (aspects of transformational leadership) positively relate to employees' job performance only when leaders' use of contingent reward (aspect of transactional leadership) is low. In our case, the negative interaction is the other way round, as the positive relationship between transactional leadership and employees' performance on a problem-solving task is significant only when the level of transformational leadership style is low. Perhaps, leaders need to focus on a purely transactional style and resource provision in terms of rewards, to be associated with an increased problem-solving performance of employees. In this respect, other resource mechanisms may hold true for problem-solving as compared to general job performance.

The current study applied general cognitive tasks to examine employees' cognitive performance. While these tasks do not reflect the tasks leaders assign to employees, they have been shown to reflect individuals' cognitive performance in the literature. As such, rather than measuring the relationship between leadership and employees' task performance, the relationship between leadership and employees' general cognitive performance was investigated. General cognitive performance in turn informs us about the cognitive resources of employees and enables us to examine a more fundamental relationship between leadership and employees' cognitive performance. Nevertheless, this relationship is also very relevant for the workplace application. Indeed, previous research showed that cognitive processes have an important role to play for employee performance (e.g., Bosco et al., 2015; Chan et al., 2018).

Given our results, transactional and transformational leadership might not be effective when trying to increase employees' cognitive performance to improve job performance. Even though the results should be examined more closely, only in the

case of employees' problem-solving performance, it might be useful for organizations to focus on transactional leadership particularly in the absence of transformational leadership. Alternatively, organizations might want to increase employees' cognitive performance by focusing on other measures that have been shown to be useful in the literature. For example, computerized cognitive training programs in which individuals practice working memory skills have been shown to increase working memory performances (Chan et al., 2018; Diamond, 2013).

Limitations and Future Research

Like any study, the present research has limitations. First, data was collected from two organizations only, which may limit the generalizability of our findings. Hence, future research should be carried out with a wide range of professions and in different cultures. Yet, given that we focused on two organizations, the advantage is additional control of the contextual properties as opposed to a wide array of structural and cultural variance.

Second, the sample size of the present study is small, which may further impede its generalizability. Additionally, it may undermine the statistical power of the study. A replication study with a larger sample would be helpful to further refine and validate the study findings. Moreover, a priori analyses concerning the required sample size would improve the research.

Third, the present research used different cognitive tests to examine employee cognitive performances. It would be valuable to also include psychophysiological measures of cognitive resource usages such as the measurement of pupillary dilations (e.g. Karatekin et al., 2007) in future research. Additionally, including the leader rated performance of the employees could further validate and extend the current study findings.

Fourth, our study design does not allow us to draw causal conclusions. Therefore, future research should be carried out employing an experimental design,

in which transformational and transactional leadership styles or concrete resource enhancing leadership behaviors are manipulated (scenario-based or by manipulating the examiner's behavior).

Fifth, it may be argued that attention, working memory, and problem-solving performance are stable in time (Chan et al., 2018). As such, more stable factors such as the socio-economic status might influence performance. The current study did not control for these factors. However, as several scholars argue, attention, working memory, and problem-solving performances are trainable and as such not as stable as sometimes assumed (Chan et al., 2018; Diamond, 2013). A diary study design might give more insights into daily fluctuations in cognitive task performance based on differing leadership behaviors.

Sixth, while we argued for a relationship between (transformational and transactional) leadership and employees' cognitive performance through the provision of resources by leaders, the current study did not include mediators. We argued that transformational and transactional leadership provide resources to employees in terms of, for example, vision (transformational leadership) and feedback (transactional leadership). These resources in turn would translate to cognitive resources through resource accumulation. Future research may investigate whether mediators such as vision and feedback indeed play a role in the relationship between leadership and employees' cognitive resources or performance.

Finally, future research is needed to determine not yet studied energy resources that may be provoked in employees by leaders and that may affect employee outcomes. Moreover, the interplay between the three resources as postulated by COR (i.e., conditions, personal characteristics, and energy resources) needs further and closer examination. This is also of importance in light of the leadership literature, which has reframed the COR resources into other conceptual

processes such as emotional resources. A deeper understanding of the role of emotional resources within the COR framework is needed.

Conclusion

Even though COR has been examined widely in the leadership literature, its investigation to date is fragmented and unstructured. Not all resources have been examined and the conceptual fundaments of COR have been rephrased. This research shows that even though it has been put forward that leaders are able to stimulate employees' cognitive 'energy' as a third resource in COR theory, little evidence could be found in this study concerning cognitive energy resources. Such a finding is intriguing in the light of the research that has successfully relied on COR, certainly warranting further and closer examination of the importance of COR for leadership research.

Chapter 4:

Bounded Safety: When Knowing How to Act Safely is Not Enough to Do So

Abstract

An underlying assumption in the safety literature is that mere motivation, skills, and knowledge are sufficient to behave safely. Yet, in line with bounded ethicality research and recent suggestions in the safety literature, we contend that situational factors play a considerable role in individuals' safety behavior and introduce the term *bounded safety*. We hypothesize a positive influence of perceived responsibility for safety and a negative influence of cognitive load on individuals' safety compliance and safety performance. Additionally, we expect that responsibility buffers the negative effect of cognitive load on safety compliance and performance, and that all relations are moderated by individuals' personality.

We employed a lab experiment with 93 participants, who acted in the role of security guard. Responsibility (high/low) and cognitive load (yes/no) were manipulated, leading to a 2 x 2 level mixed-factorial design, while personality was assessed with a survey. As safety performance outcome, we measured participants' performance in identifying targets of a potential threat, and as safety compliance outcome, we looked at whether participants reacted to a distractor. The results of ANOVAs and logistic regression analyses showed neither support for an effect of responsibility or cognitive load, nor for their interaction in influencing individuals' safety performance or compliance. However, neuroticism and extraversion moderated the interaction between responsibility for safety and cognitive load on safety compliance, and openness moderated responsibility's impact on safety compliance.

The current study adds to the safety literature by arguing for a possible influence of situational factors on individuals' safety performance and compliance and by introducing the term *bounded safety*. While the influence of perceived responsibility for safety and cognitive load was not confirmed, the two aspects do seem to have differential effects depending on individuals' personality.

Keywords: safety behavior, safety performance, safety compliance, responsibility for safety, cognitive load, personality, Big Five

Introduction

A focus on workplace safety prevents accidents and incidents, consequently sparing people's lives and health and being economically savvy (Beus et al., 2016; Hofmann et al., 2017). Research has accumulated on the antecedents of safety and delivered substantive empirical evidence of the importance of employees complying with safety measures and enacting safety performance for workplace safety (e.g., Christian et al., 2009; Clarke, 2012; Cornelissen et al., 2017). Many antecedents of safety compliance and safety performance have been found. Specifically, individual difference variables (e.g., personality), job characteristics (e.g., job demands and resources), as well as organizational and group contextual factors (e.g., leadership and safety culture) have been studied and shown to be important for safety behavior, of which safety compliance is an important component and to which safety performance is closely related. Moreover, these antecedents operate via proximal antecedents, such as behavior-outcome expectancies and safety motivation, knowledge, and skills (Beus et al., 2016). Griffin and Neal (2000) even pronounce the importance of motivation, knowledge, and skills by stating: "Safety performance… must be determined by knowledge and skills necessary for particular behaviors and by the motivation of individuals to perform the behaviors" (p. 349).

This assumes though that if people have sufficient motivation, knowledge, and skills, safety compliance and performance is ensured. Research on decision-making, however, assumes a more nuanced view, in which human cognition and behavior is often distracted by specific elements in the situation at hand (e.g., Simon, 1997). That is, there are systematic weaknesses in how humans make decisions (i.e., deciding to act safely; Simon, 1997). Indeed, research on ethical decision making, addressing whether people behave in a moral and ethical fashion, illustrates that even though people know what is right, they do not always judge and act consistently with their moral views (De Cremer & Moore, 2020). This is known as

bounded ethicality, which refers to situational factors and psychological factors that restrict ethical decision-making and lead people to unconsciously behave inconsistently with their ethical standards (e.g., De Cremer & Vandekerckhove, 2017; Tenbrunsel et al., 2010; Zhang et al., 2014). For example, research shows that people judge and react to unethical behavior more (or less) depending on whether they (do not) know who the victim is or whether the consequences are negative (or positive; Gino et al., 2010). Whereas in fact, from a moral point of view, the judgment of the behavior ought not to be dependent on personal bonds with the victim. Hence, human decision making for moral behavior is flawed and depends on specific situational features. This discussion of decision-making towards safe behavior has yet to start in the safety literature. For example, Beus and Taylor (2018) discussed possible variations in safety behavior in individuals depending on the situation and suggested a within-person process model of safety behavior. We aim to further build upon this notion and envisage contributing to the safety literature by introducing what we call "bounded safety" and what refers to the situational and psychological factors that restrict people from acting as safely as would be consistent with their own principles, knowledge, and skills. We argue that even though organizational members are well informed and have sufficient expertise and motivation to behave safely in the workplace, situational determinants may influence such safety behavior. As such, relying on expertise and motivation may not be sufficient to keep the workplace safe.

The current study focusses on two situational factors, perceived responsibility for safety and cognitive load. First, perceived responsibility for safety can be defined as "individual feeling of being personally in charge of setting and striving to ensure safe work conditions in all circumstances, even if this falls beyond the formal role accountabilities or technical tasks and requirements of a job position" (Curcuruto et al., 2016, p. 146). Second, cognitive load, also called *cognitive business* (e.g.,

Gilbert & Hixon, 1991; Gilbert & Osborne, 1989), refers to being "simultaneously involved in several resource-consuming tasks" (Gilbert & Hixon, 1991, p. 510). Perceived responsibility and cognitive load have been shown to play an important role in ethical behavior, and are particularly relevant in the safety context, as they signify the high-stake safety environment and the sustained vigilance that is needed.

We also investigate the moderating role of personality. As suggested by Beus and Taylor (2018), we contend that an individual's personality may mitigate or strengthen the impact of situational factors on safety behavior and performance. Indeed, personality has been argued to be an important factor in conjunction with contextual elements when examining people's behavior (Mischel, 2004). Investigating personality traits as boundary conditions is important to understand the influence of situational factors on safety behavior and performance more comprehensively. Similarly, while in the ethics literature, interactions between individual and situation factors have been found (Gino et al., 2011; Treviño et al., 2006), the interaction between personality and situational factors still needs investigation in the safety literature.

Different conceptualizations of safety behavior exist, but our focus is on *safety compliance*, which refers to carrying out basic safety activities to maintain workplace safety, for example by behaving in accordance with safety rules. It is the equivalent of task performance behavior, and as such the core of safety behavior (Griffin and Neal, 2000). Safety compliance can be distinguished from safety behaviors that are equivalent to contextual performance behaviors, called safety participation (Griffin & Neal, 2000) or safety citizenship behavior (Hofmann et al., 2003).

Besides safety compliance, we also focus on *safety performance.* Unfortunately, this term is used inconsistently in the literature (Christian et al.,

2009; Griffin & Hu, 2013). While some authors use it as synonym to safety behavior (e.g., Griffin & Neal, 2000), others use it to refer to safety outcomes, such as accidents (e.g., Curcuruto et al., 2015). Moreover, the term can describe something in between. For example, Yang et al. (2020) called errors made by pilots safety performance. Even though they argue that is a safety outcome, we contend that errors can lead to safety outcomes such as accidents, yet not necessarily do so. Therefore, in our view it is necessary to distinguish between a) safety behavior, b) safety performance, and c) safety outcomes. As safety outcomes are the least influenced by psychological factors and individual behaviors, as often many other factors play a role for safety outcomes to occur (Christian et al., 2009), the current study focusses on safety behavior (more specifically safety compliance) and safety performance.

Theory and Hypotheses

Beus and Taylor (2018), and Beus and colleagues (2016) recently criticized that the current literature on workplace safety is unable to explain why individuals behave more safely in some instances than in others. The existing literature does not yet address how safety behavior can change in different circumstances. Beus and Taylor (2018) proposed a "within-person process model of safety-related behavior" (p. 7), which suggests that the choice between a safety-focused and a non-safety-focused goal is influenced by the characteristics of the safety target, the characteristics of the safety behavior, and the severity and immediacy of the associated threat. According to the model, the goal choice influences whether an individual behaves safely. Beus and Taylor (2018) argue that "safety-related behaviors (like any workplace behaviors) are functions of goal choice and are likely to vary within-person over time as circumstances and priorities change" (p. 1).

Hence, even though people have the best intention to act safely, from the above, it can be derived there are processes at play related to the situation at hand

that would influence the decision-making process to act safely or not. These processes align with a neighboring research domain of ethical decision-making, which showed that albeit with the best intentions, people do deviate from moral compliance when seemingly unrelated situational factors are present, a process that is referred to as bounded ethicality. Furthermore, research showed that deviations from ethical behavior happen without bad intentions and unconsciously, elicited by self-interest and/or blind spots concerning the unethicality of one's own behavior (De Cremer & Moore, 2020; Gino et al., 2011; Palazzo et al., 2012). As Zhang et al. (2014) put it: "even if we care about being moral, most of us—under certain social or situational pressures—act unethically" (p. 64). Bounded ethicality describes that unethical behavior is often performed unconsciously and without awareness of acting against one's consciously held ethical standards, due to "systematic and predictable blind spots" (Sezer et al., 2015, p. 77). A variety of situational factors have been found that influence to what extent one behaves ethically, such as perceived responsibility (e.g., Schwartz, 1968) and cognitive load (e.g., Gino et al., 2011).

The processes for safety behavior and performance seem to align to some extent with those for ethical behavior. Like safety behavior, ethical behavior often is required on top of regular task duties, for example. Moreover, safety compliance relates to safety performance, which both have a moral component, as they concern the safety and health of others. Employees (in high-risk environments) can be said to have an ethical obligation to serve for a safe environment (Yuan et al., 2020). Despite these similarities, both research domains have rarely been integrated. Here, we draw from the bounded ethicality literature to introduce bounded safety as the processes that influence the decision-making process of acting unsafely *despite proper objective expertise or knowledge*. In order to examine these processes, we

draw the line with the bounded ethicality literature and focus on responsibility and cognitive load as factors influencing people to act (un)safely.

Impact of Responsibility and Cognitive Load on Safety Performance and Compliance

Responsibility and Safety

The literature on ethical decision-making found that if individuals feel personally responsible for the harm of others, they make more pro-social decisions by not harming or punishing others, for example for non-cooperative behavior (Molenmaker et al., 2016). In their review of (un)ethical behavior in organizations, Treviño et al. (2014) state that "the ascription of responsibility to the self has long been considered important to ethical decision making" (p. 646) and refer to a study of Schwartz (1968), who found that perceived responsibility is necessary to activate pertinent norms, which, in turn, is necessary to behave in accordance with one's norms.

Psychological processes can lead to a decreased feeling of ethical responsibility by "fading" the ethical components of an ethical decision or situation, a process called *ethical fading* (Tenbrunsel & Messick, 2004). As a consequence, individuals are less inclined to act ethically (Tenbrunsel & Messick, 2004). An individual's moral awareness is high "when an individual interprets a situation as containing ethical issues or as relevant to moral principles" (Chugh & Kern, 2016, p. 93). Individuals may morally disengage, for example by diffusing or displacing the responsibility to others, thereby facilitating unethical behavior (Bandura, 1999). On the other hand, moral awareness can be increased; for example, the display of moral symbols, due to their strong association with moral concepts, increases the accessibility of the concept of morality in individuals' minds. This accessibility increases individuals' moral awareness by letting them note that the situation may involve ethical content. In turn, moral awareness leads to a decrease in unethical

behavior (Desai & Kouchaki, 2017). Moreover, moral awareness is high when individuals feel responsible for the outcomes of their conduct (Bandura, 1999).

Explicitly imposing the responsibility to an individual may increase moral awareness and counteract moral disengagement and therefore increase ethical behavior. Indeed, feeling accountable for one's actions, which creates awareness about responsibilities, has been shown to reduce unethical behavior (Desai & Kouchaki, 2015). Applying the reasoning to safety, we argue that making individuals aware of their responsibility for safety may trigger them to enact heightened safety compliance and performance. Responsibility prompts safety awareness and accountability, which motivate people to comply with safety standards. For example, the importance of individual accountability for safety compliance has been put forward in the healthcare industry (e.g., Aveling et al., 2016). Furthermore, Curcuruto et al. (2019) argued that to enact safety compliance, individuals need a "reason to" motivation. While the authors state that safety rules and regulations fulfil the "reason to" motivation, we contend that feeling responsible and accountable may further increase this motivation. Moreover, when individuals are made aware of their responsibility, they wish to protect their view of themselves as "good" individuals, which increases their awareness of the consequences of their behavior and decisions (cf. Chugh & Kern, 2016 in the bounded ethicality literature).

In a study that examined the role of responsibility (without explicitly mentioning *safety* though), Ladouceur et al. (1995) manipulated responsibility and investigated its effect on a classification task in which participants needed to categorize pharmaceutical capsules into the correct pill bottles. In the high responsibility condition, participants were told "that they had great responsibility in the project because their results in the classification of capsules could directly influence the manufacture of the medication" (Ladouceur et al., 1995, p. 942). Moreover, they were told that seriously completing the task may "prevent serious

consequences from happening" (Ladouceur et al., 1995, p. 942). The instructions also included the notion that a classification system was developed to "make the distribution of mediation safer for the inhabitants" (Ladouceur et al., 1995, p. 942). Thus, it was implied that the health and safety of others would depend on the participants. The authors found that even though the needed time and number of errors were not significantly different between the groups, participants with high responsibility did show more checks and hesitations than the low responsibility participants.

Perceived responsibility for safety is, moreover, included in the safety literature as safety attitude (Clarke, 2000; Henning et al., 2009; Turner & Parker, 2004), aspect of safety culture/climate (Clarke, 2000), and a dimension of a pro-active safety role orientation (Curcuruto et al., 2016). Lack of clarity about responsibilities regarding safety are regularly involved in incidents (Lekka & Healey, 2012). Moreover, at a team-level, feeling responsible for safety seems to be related to safer working (Turner & Parker, 2004).

Hofmann, Morgeson, and Gerras (2003) researched safety citizenship role definitions, referring to the extent to which employees feel that safety citizenship behavior is part of their role and thus their responsibility. They found that safety citizenship role definitions are positively related to safety citizenship behaviors. Thus, feeling responsible for certain safety behaviors seems to increase these behaviors. Moreover, Curcuruto and colleagues (2016) investigated felt responsibility as one dimension of a pro-active safety role orientation and found that this dimension is related to different safety citizenship behaviors. Taken together, we hypothesize:

Hypothesis 1a: Individuals in the high (vs. low) responsibility for safety condition demonstrate higher safety performance.

Hypothesis 1b: Individuals in the high (vs. low) responsibility for safety condition demonstrate higher safety compliance.

Cognitive Load and Safety

Cognitive load leads to the occupation of a part of the working memory capacity (Allred et al., 2016). Working memory is, in turn, important for cognitive activities such as reasoning, critical thinking, decision making, negotiating, or organizing task priorities (Chan et al., 2018; Diamond, 2013; Redick & Lindsey, 2013), which all may be important for safety behavior and performance. Cognitive load also reduces the conscious attention one can devote (Krull, 1993) and is related to aspects such as impulsiveness and impatience, mistakes, reduced self-control, poor information processing, and impaired performance on visual judgement tasks (Allred et al., 2016). These aspects are all relevant for safety. For example, as a consequence of cognitive load, less attention may be devoted to safety rules or more mistakes may be made, which may lead to reduced safety compliance and performance.

The decision-making literature suggests that cognitive load leads to an increased use of automatic information processing strategies, a greater role of decision heuristics, more automatic and impulsive behaviors, and less thought-driven behaviors or deliberation (e.g., Hauge et al., 2016; Roch et al., 2000; Schulz et al., 2014). Whether altruistic and moral behavior is more impulsive than selfish and immoral behavior, or it is the other way round, is an ongoing debate in the literature (Hauge et al., 2016; Schulz et al., 2014). However, many ethical decisions and behaviors need deliberation, in the first place to recognize the ethical nature of a situation, and consequently to take a proper ethical decision and behave accordingly (Street et al., 2001). Consequently, cognitive load, by eliciting more automatic thinking and behavior and less recognition of the situation's ethical nature, leads to more unethical behavior (Sezer et al., 2015; Street et al., 2001). We

contend that enacting safety compliance and performance, too, often requires thoughtful action, and thus cognitive load is expected to lower safety compliance and performance.

From the ethical literature, we can also infer that self-control, defined as "the capacity to alter one's responses, such as by overriding some impulses in order to bring behavior in line with goals and standards" (Mead et al., 2009, p. 594) is needed for ethical behavior. Self-control is a limited resource and a reduction in cognitive self-control resources (i.e., ego-depletion) leads to more unethical behavior due to impaired moral awareness (Gino et al., 2011). We argue that – given that we expect that safety behavior like ethical behavior is effortful – when individuals face cognitive load, their ability to test their behavior against (internal or external) safety standards and to override their impulse of doing something non-safety-related is constrained, leading to a decrease in safety compliance and performance. Indeed, recent studies suggest and show that safety behavior depends on self-control resources and a depletion of these resources leads to more risk-taking, unsafe behaviors, and decreased safety performance (Fischer et al., 2012; Yuan et al., 2020).

There is a considerable amount of research on the relationship of job stressors such as workload, role overload, and cognitive demands on the one hand and impaired safety behavior and performance on the other hand. An important difference exists between this research and ours, though, as the mentioned research is about general stressors (i.e., load) in the workplace, while we investigate the situational momentary influence of cognitive load. Yet, findings on the impact of general overload may underpin our expectation of a situational influence of cognitive load. In a meta-analysis, Nahrgang, Morgeson, and Hofmann (2011) found that physical demands (among which workload) and complexity (among which task complexity and cognitive demands) are related to unsafe behavior and adverse

safety events (via burnout and engagement). In another meta-analysis, Clarke (2012) found that challenge stressors (i.e., eliciting stress that is appraised as challenging and developmental), among which work overload, are not related to safety compliance. However, hindrance stressors (i.e., eliciting stress that is appraised as hindering one's functioning; among which role overload) are negatively related to safety compliance and safety participation and eventually occupational injuries. The author mentions cognitive failures, a greater vulnerability to errors, lowered concentration, increased distractibility, and emotional exhaustion as possible mechanisms between stressors and safety behavior (Clarke, 2012). Task-related additional cognitive load can be regarded a hindrance stressor and as such expected to reduce safety behavior and performance as equivalent with job stressors. Additionally, role overload is a hindrance stressor that increases cognitive load (Conchie et al., 2013). Studies investigating role overload independently from other hindrance stressors mostly found that it is related to unsafe behaviors, safety-related event, and injuries (Barling et al., 2002; Conchie et al., 2013; Zohar, 2000), although other studies did not observe a relationship between role overload and safety compliance (Parker et al., 2001; Yuan et al., 2015).

Finally, multi-tasking, increasing one's cognitive load, may lead to cognitive failures (Robertson et al., 1997). Cognitive failures are execution lapses in attention / perception, memory, or motor functions, leading to unintended outcomes (Broadbent et al., 1982; Wallace & Chen, 2005). Workplace cognitive failures are related to reduced safety compliance and more work-related accidents (Wallace & Chen, 2005). Thus, cognitive load may lead to reduced safety compliance and performance. Therefore, we hypothesize:

Hypothesis 2a: Individuals in the high (vs. low) cognitive load condition demonstrate lower safety performance.

Hypothesis 2b: Individuals in the high (vs. low) cognitive load condition demonstrate lower safety compliance.

Interaction Between Responsibility and Cognitive Load

Cognitive load may have less of an impact on safety compliance and performance if individuals are driven to behave safely because they feel responsible for safety. For example, difficult performance goals may lead to unethical behavior due to ego-depletion and an impaired activation of moral standards, but not when individuals receive (un)ethical priming (Welsh & Ordóñez, 2014a, 2014b). This priming induces ethical norms and, as such, is related to perceived responsibility.

Relatedly, Yam et al. (2014) found that ego-depletion is associated with more unethical behavior only when the unethical behavior is of low social consensus, referring to a low amount of social agreement on the ethical nature and the evilness of the behavior. However, when the unethical behavior is of high social consensus, and thus generally agreed to be unethical, ego-depletion is related to *less* unethical behavior. The authors argue that for low social consensus, behaving unethically is the default behavior, which occurs during automatic processing, while behaving ethically would need deliberate thinking. For high social consensus, however, it is the other way round (Yam et al., 2014). Similarly, Gino et al. (2011) found that depletion only leads to more unethical behavior for individuals low in moral identity, reflecting "the extent to which an individual identifies him/herself as a moral person" (Gino et al., 2011, p. 193). Individuals high in moral identity are not influenced by depletion, as they do not need cognitive resources to identify a behavior as unethical (Gino et al., 2011). Similarly, when individuals feel responsible for safety, they can be expected to not need cognitive resources to identify the safety consequences of their behavior. As such, especially for low felt responsibility, cognitive load may influence individuals' safety compliance and performance.

We argue that for low responsibility, individuals may have the automatic tendency to enact reduced safety compliance and performance, but are distracted or just pay less attention. As resources are needed to overrule this tendency, cognitive load (vs. no cognitive load) leads to reduced safety compliance and performance. However, perceiving to be responsible for safety should lead individuals to identify their behavior as safety-relevant such that they do not need additional resources for it. As such, individuals should be more prone to behave safely, disregarding whether they are in an automatic or deliberate processing mode, and thus independently of their cognitive load. Taken together, we formulate:

Hypothesis 3a: Responsibility for safety moderates the relationship between cognitive load and safety performance. In the low responsibility condition, safety performance is lower when cognitive load is high (vs. low).

Hypothesis 3b: Responsibility for safety moderates the relationship between cognitive load and safety compliance. In the low responsibility condition, safety compliance is lower when cognitive load is high (vs. low).

Interaction with Personality

The five-factor model for personality describes individuals' personality and is comprised of the traits conscientiousness, agreeableness, neuroticism, openness, and extraversion, also called the *Big Five* (McCrae & Costa, 1987). It is widely accepted and established as the dominant personality model (Simha & Parboteeah, 2019).

Meta-analytic research has demonstrated "the value of considering personality traits as key correlates of workplace safety" (Beus et al., 2015, p. 481). Agreeableness and conscientiousness are negatively, and extraversion and neuroticism positively associated with unsafe behaviors and accidents (Beus et al., 2015; Clarke & Robertson, 2005). Moreover, Beus and Taylor (2018) propose a

moderating role of personality on the relationship between within-person determinants of safety behavior and safety behavior itself.

In the ethics literature, support is found for interactions between person factors (individual differences) and situation factors (Gino et al., 2011; Treviño et al., 2006), and it has been suggested to investigate this interaction on safety (e.g., Christian et al., 2009). However, the moderating role of personality traits has not been investigated in the safety literature so far. Yet, individual difference variables may influence interpretations of responsibility for safety, as suggested by Zackowitz (2001), or they may influence individuals' reactions to responsibility. Moreover, individual differences affect the extent to which individuals are influenced by cognitive load or ego-depletion (Gino et al., 2011; Schmidt et al., 2012; Szymura & Wodniecka, 2003).

Conscientiousness

Individuals who are highly conscientious are dutiful, scrupulous, well organized, hardworking, ambitious, self-disciplined, and persevering. They tend to adhere to plans, schedules, and requirements, while individuals scoring low on conscientiousness are undirected and lazy (McCrae & Costa, 1987). Referring to highly conscientious individuals, McCrae and Costa (1987) stated:

Certainly individuals who are well organized, habitually careful, and capable of self-discipline are more likely to be able to adhere scrupulously to a moral code if they choose to—although there is no guarantee that they will be so inclined. (pp. 88-89)

Thus, highly conscientious individuals who feel they are personally responsible for safety - and therefore choose to serve for safety - are expected to show a high amount of safety compliance and safety performance. In contrast, highly conscientious individuals who do *not* feel responsible are likely to not choose to serve for safety and, therefore, show a lower amount of safety compliance and

performance. On the other hand, "an undirected individual may have a demanding conscience and a pervasive sense of guilt but be unable to live up to his or her own standards for lack of self-discipline and energy" (McCrae & Costa, 1987, p. 89). Consequently, individuals low in conscientiousness may enact low safety compliance and performance, only limitedly influenced by their felt responsibility. Taken together, we propose:

> *Hypotheses 4a: Conscientiousness moderates the relationship between responsibility for safety and a) safety performance and b) safety compliance. For high conscientiousness, a) safety performance and b) safety compliance are higher when responsibility for safety is high (vs. low).*

Further, given conscientious individuals' reliable and perseverant nature, cognitive load may play less of a role for them. On the other hand, low conscientious individuals' lack of directedness, self-discipline, and energy may make them especially prone to be affected by cognitive load. Moreover, we argued above that cognitive load may lead to a decrease in safety compliance and performance due to cognitive failures. However, as conscientiousness is negatively related to cognitive failures (Wallace & Chen, 2005), we expect especially low conscientious individuals (vs. highly conscientious individuals) to be affected by cognitive load.

Support for our expectation comes from the finding that having a high capacity for self-control, which is a facet of conscientiousness (Bogg & Roberts, 2004; Roberts et al., 2014), may buffer the negative impact of self-control demands on employees' exhaustion, such that the negative impact vanishes for individuals with a high self-control capacity (Schmidt et al., 2012). As such, we expect that highly conscientious individuals are less affected by the self-control demands of cognitive load, while especially individuals low in conscientiousness are negatively affected by it. Taken together, we formulate:

Hypotheses 4b: Conscientiousness moderates the relationship between cognitive load and a) safety performance and b) safety compliance. For low conscientiousness, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).

Finally, we expect the interaction between cognitive load and responsibility to be present especially for highly conscientious individuals. Highly conscientious individuals who perceive a high responsibility for safety are expected to be influenced by cognitive load only to a small extent, as they are very concerned with safety and able to behave as safely as possible, not letting other tasks distract them. However, highly conscientious individuals who perceive a low responsibility are not very motivated to behave safely and should be easily affected by cognitive load. In contrast, individuals low in conscientiousness are expected to be impacted by cognitive load, which, due to their undirected nature, should hold irrespective of their felt responsibility. Taken together, we propose:

Hypotheses 4c: Conscientiousness not moderates the interaction between responsibility for safety and cognitive load on a) safety performance and b) safety compliance. For high conscientiousness and low responsibility, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).

Agreeableness

Highly agreeable individuals are friendly, cooperative, trustful, sympathetic, and concerned, while individuals low in agreeableness set themselves against others, are distrustful, skeptical, callous, and rude (McCrae & Costa, 1987). Agreeable individuals are fair, just, and less likely to justify behaviors that may harm people (Simha & Parboteeah, 2019). Due to those characteristics, we expect that when agreeable individuals feel responsible for safety, they will especially do their utter best to serve for safety by enacting more safety compliance and performance.

On the other hand, individuals low in agreeableness care little about safety due to their callousness, and their behavior is expected to differ to a smaller extent under high and low responsibility.

In support of this, Liu et al. (2019) found that having a sense of power leads to a felt obligation and consequently higher prosocial behavior (i.e., donation) intentions in case of high, but not in case of low moral identity. A strong moral identity is comparable to and correlates highly with agreeableness (Goodwin et al., 2020). Similar to a sense of power, highly vs. low agreeable persons may translate the induced responsibility differently into felt obligation and consequently prosocial behavior (i.e., safety compliance and performance). Specifically, especially highly agreeable persons may feel an increased obligation and consequently show more safety compliance and performance as a response to induced responsibility. Accordingly, we hypothesize:

> *Hypotheses 5a: Agreeableness moderates the relationship between responsibility for safety and a) safety performance and b) safety compliance. When agreeableness is high, a) safety performance and b) safety compliance are higher when responsibility for safety is high (vs. low).*

Regarding cognitive load, Gino et al. (2011) found that ego-depletion had no impact on ethical behavior of individuals high in moral identity. Due to those individuals' internalization of moral standards, they do not need cognitive resources to behave ethically. Similarly, highly agreeable individuals can be expected to have an internalization of helping others and thus behaving safely, needing no cognitive resources to do so. By consequence, we expect that those individuals are only to a limited amount influenced in their safety compliance and performance by cognitive load. On the other hand, individuals low in agreeableness may need to overcome their intuitive choice of doing something else instead of behaving safety compliant and performing well. This would require cognitive resources and be impaired by

cognitive load. Supporting our expectation, Yuan et al. (2020) found that attentional bias towards safety moderates the impact of emotional exhaustion on safety compliance, such that emotional exhaustion is negatively related to safety compliance for individuals having a low attentional bias towards safety, but unrelated for individuals having a high attentional bias towards safety. Attentional bias towards safety reflects "employees' automatic motivational state toward safety" (Yuan et al., 2020, p. 214), which should be characteristic for highly agreeable individuals. Thus, we formulate:

Hypotheses 5b: Agreeableness moderates the relationship between cognitive load and a) safety performance and b) safety compliance. When agreeableness is low, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).

Furthermore, parallel to our reasoning concerning conscientiousness, we expect the interaction between cognitive load and responsibility to be present especially for highly agreeable individuals. When those individuals perceive a high responsibility for safety, cognitive load influences them only minimally, as their concern for others and thus safety makes them less distractible by other tasks. Yet, we expect cognitive load to strongly affect highly agreeable individuals who perceive a low responsibility for safety, as they perceive less of a need to behave safely. On the other hand, we expect that the impact of cognitive load on individuals low in agreeableness, due to their callousness, is less differential for high or low responsibility. Hence, we hypothesize:

Hypotheses 5c: Agreeableness moderates the interaction between responsibility for safety and cognitive load on a) safety performance and b) safety compliance. For high agreeableness and low responsibility, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).

Neuroticism

Individuals high in neuroticism are characterized by negative affect and by emotional distress disturbed cognitions (e.g., worrying) and behaviors (e.g., impulsive behaviors). In contrast, individuals low in neuroticism are emotionally stable and calm (McCrae & Costa, 1987). Highly neurotic individuals (vs. low neurotic individuals) generally behave less safety compliant and safety performant, as their preoccupation with negative emotions leads to distracted thinking and irrational safety behavior choices (Beus et al., 2015). Consequently, responsibility may have less of an impact on safety for highly neurotic individuals, as they are only restrictedly able to enact safety compliance and performance. Moreover, responsibility may imply a stressor for neurotics, which they tend to react to with avoidant, tension-reduction coping (Ashraf & Sitwat, 2016). On the other hand, the emotional stability of individuals *low* in neuroticism enables them to behave more safety compliant and performant as reaction to responsibility. Therefore, we propose:

> *Hypotheses 6a: Neuroticism moderates the relationship between responsibility for safety and a) safety performance and b) safety compliance. When neuroticism is low, a) safety performance and b) safety compliance are higher when responsibility for safety is high (vs. low).*

Additional cognitive load negatively influences the (visual attention) task performance of individuals high in neuroticism much stronger than that of individuals low in neuroticism. This is because cognitive load is stressful and impairs central cognitive processes of neurotics (Szymura & Wodniecka, 2003). Similarly, Lawton and Parker (1998) argued that instable and thus neurotic individuals are likely to respond to stress in ways that increase the risk of accident involvement by violating rules or committing more errors. At the same time, individuals high in self-control capacity (i.e., having high control over emotions,

impulses, and thoughts, and thus similar to low neuroticism) are less affected by self-control demands, such as resisting distractions (Schmidt et al., 2012).

Moreover, as cognitive load may lead to a decrease in safety compliance and performance due to cognitive failures and neuroticism is positively related to cognitive failures (Wallace & Chen, 2005), neurotic individuals (vs. low neurotic individuals) are expected to be more affected by cognitive load. Taken together, we hypothesize:

Hypotheses 6b: Neuroticism moderates the relationship between cognitive load and a) safety performance and b) safety compliance. When neuroticism is high, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).

Finally, we expect the interaction between cognitive load and responsibility to be especially pronounced for individuals low in neuroticism. For these individuals, we expect that cognitive load has an impact especially under low responsibility. Indeed, under high responsibility, emotionally stable individuals want to do their best for safety and are interfered by cognitive load only to a limited extend. Under low responsibility, emotionally stable individuals have less of a wish to enact safety compliance and safety performance, and are thus more easily impacted by cognitive load. On the other hand, we expect that the influence of cognitive load on neurotic individuals' safety compliance and performance is less affected by their felt responsibility. As we argued for above, responsibility has generally less of an impact on neurotic (vs. emotionally stable) individuals. Therefore, we state:

Hypotheses 6c: Neuroticism moderates the interaction between responsibility for safety and cognitive load on a) safety performance and b) safety compliance. For low neuroticism and low responsibility, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).

Openness

Openness to experience, in short "openness", describes the extent to which individuals are original, imaginative, creative, and independent, have broad interests, and prefer variety (McCrae & Costa, 1987). The moderating influence of openness to experience is less clear-cut. For example, for individuals high in openness, it may be that high responsibility leads to more safety compliance and performance, as those individuals are flexible and adapt well to demands (Benoliel & Somech, 2014). However, it may also be that responsibility leads those individuals to enact reduced safety compliance and performance, as they seek sensation, question authority, and want to restore their feeling of autonomy by deviating from what is expected from them (Beus et al., 2015).

Empirically, Benoliel and Somech (2014) found that the relationships between participative leadership, which places an increased responsibility on employees, and employees' in-role performance and psychological strain, were not moderated by openness (while they were moderated by the other *Big Five*). Moreover, openness is unrelated to safety behavior (Beus et al., 2015).

Similarly, cognitive load may motivate individuals high in openness to enact more safety compliance and performance, as they prefer variation and challenge. On the other hand, cognitive load may evoke deviation in those individuals. Based on the equivocal nature of the theoretical and empirical evidence, we make no hypotheses regarding the moderating role of openness.

Extraversion

Extravert individuals are sociable, lively, sensation seeking, assertive, and active, while individuals low in extraversion, introverts, are retiring, sober, reserved, and quiet (McCrae & Costa, 1987). Due to their sensation-seeking nature, extravert individuals may deliberately violate safety rules and thus behave less safety compliant than introvert individuals (Neal & Griffin, 2004). As this deliberate

violation is not present in introvert individuals, we can derive that felt responsibility may especially make a difference for them. Thus, especially for low extraversion, we expect responsibility to lead to more safety compliance and performance, and we hypothesize:

Hypotheses 7a: Extraversion moderates the relationship between responsibility for safety and a) safety performance and b) safety compliance. When extraversion is low, a) safety performance and b) safety compliance are higher when responsibility for safety is high (vs. low).

Highly extravert individuals seek sensations and are active and as such are expected to perform well in demanding situations, which cognitive load bring along. For them, cognitive load may have less of a negative effect, as it reduces the boredom of the situation and may work against their automatic reaction to do something else. In contrast, introvert individuals are expected to suffer from arousal due to cognitive load. As such, especially introverts' safety compliance and performance is likely to be negatively affected by cognitive load.

In support of this, Farmer (1984, in Lawton & Parker, 1998) found that extravert pilots performed better in demanding situations, while introvert pilots may be superior in undemanding tasks. Moreover, while cognitive load and distraction by noise do not have an impact on the performance of extravert individuals, it does have a negative impact on introverts (Dobbs et al., 2011; Lieberman & Rosenthal, 2001). Taken together, we formulate:

Hypotheses 7b: Extraversion moderates the relationship between cognitive load and a) safety performance and b) safety compliance. When extraversion is low, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).

Further, especially introverts may be stronger impacted by cognitive load when they feel they are not responsible for safety (vs. when they feel they are

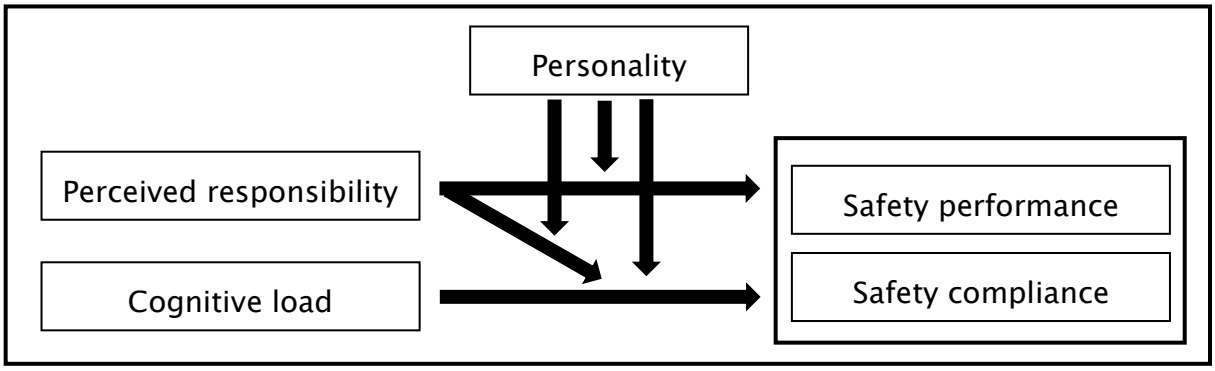
responsible). In case of low responsibility, their passivity may make them vulnerable towards the effects of cognitive load. At the same time, when introverts do feel responsible for safety, this direction may buffer the negative effects of cognitive load. On the other hand, for highly extravert individuals, we expect cognitive load to have less of a differential impact depending on the responsibility of these individuals. Thus, we propose:

> *Hypotheses 7c: Extraversion moderates the interaction between responsibility for safety and cognitive load on a) safety performance and b) safety compliance. For low extraversion and low responsibility, a) safety performance and b) safety compliance are lower when cognitive load is high (vs. low).*

We depict the proposed research model in Figure 4.1.

Figure 4.1

Conceptual Research Model



Method

To test our hypotheses, we employed an experimental design. We surveyed participants' personality and manipulated responsibility for safety and cognitive load, while measuring participants' safety compliance and performance. The task was to detect targets in surveillance footage and our framing indicated the task's safety relevance. We chose for an easy task, such that performance reflected effort

rather than ability (Mento et al., 1980). That way, we investigate to what extent individuals' effort is influenced by the independent and moderating variables.

Participants and Design

Based on current minimum norms in experimental studies, we aimed for at least 25 participants per condition (e.g., Gandarillas et al., 2018; Tobin et al., 2015). Based on four conditions, this led to 100 participants. However, of our 102 participants, three misunderstood the instructions and interrupted the experiment before completion. Moreover, six participants in the high cognitive load condition indicated to have written down the digits they needed to remember during the experiment. We excluded these participants from the analyses, leaving 93 participants.

Participants belonged to one of two groups. First, 83 participants were students who were recruited via the university's web-based experiment management system and social media. They were rewarded with course credits. Of these, 66 (71.0% of the total) were psychology students, 47 of them in their first bachelor year, seven in their second bachelor, four in their third bachelor, five in their first master and three in their second master. The resting 17 students (18.3%) were studying something else than psychology and in different years (five first year, one second year, four third year bachelor, four first year and three second year master). Second, ten participants (10.8%) were non-students (working and/or finished with their studies), who were recruited ad-hoc and received no reward for their participation.

Most participants were female (63.4%), the remainder was male (36.6%), nobody indicated "X". The mean age was 20.92 years (SD = 3.86). Participants were randomly assigned to one of four conditions of a 2 (responsibility) x 2 (cognitive load) between-participants design.

Procedure

The computer-based experiment took place in the laboratory, in individual rooms for each participant. On the computer screen, questions capturing demographics and personality were presented. Next, “background information” about the experiment was displayed. The cover story was that, to increase safety, the federal police would increasingly work together with private security guards. To ensure the safety concerning this collaboration and decide how many staff they would need for a certain amount of surveillance footage, the police wants to know how accurately security guards can notice suspected persons. To investigate this, the police has given our (the researchers’) research group a mandate. With that, we examine how accurately participants could spot persons with described characteristics on surveillance footage. Further information differed depending on the responsibility condition.

Afterwards, participants read that they would need to fulfil a task in the scope of the mentioned research. They learned they would take up a role as security guard. Participants were told that they would be searching for a person with a red garment as this person has concrete plans to carry out a terror attack. Every participant was further told that, as he/she is the only person seeing this surveillance footage, it would be crucial to watch it very attentively and make a note of the moment when persons with red garment pass by. That way, it was said, law enforcement would be able to arrest the perpetrator.

Then, a 15-minutes sequence of a shop entrance’s surveillance footage with people moving in and out was shown (Clerx Elektrotechniek, 2016). During this period, participants were distracted via a timer that went off. After the video, participants were asked to enter the times they had noted down of moments when targets (i.e., persons with a red garment) passed by.

Outcome Variables

Safety Performance

As safety performance measure, we checked how many correct times participants noted targets. In total, we defined eight correct targets, not taking into account people with orange garments and red bags and umbrellas. That way, each participant reached a score between 0 and 8 for this outcome.

Safety Compliance

As measure of safety compliance, we investigated whether participants reacted to the distractor, a timer that went off during the video-task. Before the experiment, participants were told to not let themselves be distracted by anything. They were given two colored pieces of paper and told that if they experienced a problem during the experiment, they could slip the red piece of paper under the door. When they were ready with the experiment, they could slip the green piece of paper under the door. We registered whether participants reacted to the timer. A reaction could be slipping the red piece of paper under the door or turning the volume of the speakers lower or off. For these actions, participants needed to stand up and thus interrupt looking at the video. As they were instructed to not be distracted and keep looking at the surveillance footage, a reaction to the timer was regarded as non-compliant behavior. The experimenter observed whether pieces of paper were slipped under the door and/or the volume changed and took notes. Each participant was given a score of 0 (no reaction, high safety compliance) or 1 (reaction, low safety compliance). For five participants, we have missing data due to administrative errors during the data collection.

Manipulations

Responsibility

Responsibility was manipulated via oral information at the beginning of the experiment and written information during the description of the “background”,

thus the cover story. During both instances, participants in the high responsibility condition were told that they had a high responsibility as their experiment data would be used to shape the collaboration between police and security guards. That way, they would have a direct impact on the general safety. They were also shown a (real) news-video about the planned collaboration between police and security guards. In contrast, participants in the low responsibility condition were told that the current study would only be a pilot study before the actual study. Therefore, their data would not be analyzed.

For 16 participants, due to administrative errors during the data collection, we cannot be sure that the oral information matched the responsibility condition of the written information. However, we do know which written information the participants received. Moreover, we assessed the written information as more important for the manipulation than the oral information, as the written part was more closely connected to the task instructions and illustrated with a video in the high responsibility condition. Therefore, these participants are included in the analyses, but the results of the same analyses without the mentioned participants can be found in the footnotes.

Cognitive Load

Cognitive load was manipulated via a digit rehearsal task (see Gilbert & Hixon, 1991; Gilbert & Osborne, 1989). Participants in the cognitive load condition received the additional instruction to remember an eight-digit number (49826571) for the duration of the surveillance-task. We told participants that it was essential that they remembered these digits and that their results would need to be deleted if they would not correctly recall the digits. Participants were also instructed to not write down the digits but remember them. The digits were shown for 20 seconds immediately before the surveillance footage, and participants were asked to enter

the digits at the end of the experiment. In contrast, the participants in the no cognitive load condition received no additional task.

Measures

Personality

The personality domains were assessed with the validated Dutch translation (Denissen et al., 2008) of the 30-item short form of the Big Five Inventory-2 (Soto & John, 2017). The items were rated on a scale from 1 (*totally disagree*) to 5 (*totally agree*) and the stem was "I am someone who…". An example item of the *conscientiousness* subscale is "…is reliable, can always be counted on". Cronbach's alpha for that subscale is .78. An example item of the agreeableness subscale is "…is respectful, treats others with respect" and Cronbach's alpha is .67. This is slightly below the recommended value of at least .70. However, as marginally lower values do not need to invalidate findings and deleting any item did not increase Cronbach's alpha, we continued the analyses with the full subscale. An example item measuring *neuroticism* is "…worries a lot" and the subscale has a Cronbach's alpha of .82. The *openness* subscale is measured by items such as "…is original, comes up with new ideas" and its alpha reliability is .80. Finally, an example item of the *extraversion* subscale is "…is outgoing, sociable". Cronbach's alpha of that scale is .82.

Background / Control Variables

As demographic variables, we asked participants to indicate their age, gender, study year including option "finished with studies / working", and study field. We included these questions as demographic variables such as age and gender are related to safety behavior (e.g., Pek et al., 2017). Moreover, as the experiment was conducted by two different experimenters and in four different rooms, we registered experimenter and room for each participant. Due to administrative errors

during the data collection, we have four missing values for the experimenter and one missing value for the room.

Analysis Strategy

For dealing with missing values, we applied a multiple imputation method to reduce bias and error (Newman, 2014). The five missing values for the alarm reaction, four missing values for the experimenter, and one missing value for the room were imputed 50 times. Data concerning the remaining variables was complete. The imputation was done with all manipulations, outcomes, measures, and background variables. The reported results refer to the pooled multiple imputation data set, except if specified otherwise.

In experimental designs, due to the random assignment of participants to conditions, background variables are expected to be balanced between conditions. We checked whether this was true for this experiment by investigating whether conditions differed in terms of gender, experimenter, or room by conducting Chi² tests, or in terms of age by conducting a one-way analysis of variance (ANOVA). The conditions did *not* differ in terms of gender ($\chi^2(3) = 2.93$, $p = .40$), experimenter ($\chi^2(3) = 1.39$, $p = .71$), or room ($\chi^2(15) = 17.31$, $p = .30$).[11] The conditions did not differ in terms of age either ($F(3, 89) = 1.46$, $p = .23$, $\eta^2 = .05$). Given these results, the background variables are balanced between the conditions, such that we will not need to control for their impact.

For the cognitive load manipulation check, we asked participants in the cognitive load condition how difficult they perceived the memory task (Allred et al., 2016; Krull et al., 2008) on a scale from 7 (very easy) to 0 (very difficult). None of the respondents indicated 7 and a simple t-test revealed that the *Mean* of 3.57 (*SD*

[11] The Chi² tests are based on the original data, as SPSS does not allow for pooled Chi² outputs. Concerning the room, we must be cautious with interpreting the results, as 66.7% of the cells had an expected count below 5 and the minimum expected count was .22. This is not unexpected due to the number of cells with six rooms and four conditions (i.e., 24).

= 1.52) was significantly different from 7 ($t(41) = -14.65$, $p < .001$). Additionally, we asked the participants in the cognitive load condition whether they had written down the digits, and if they answered yes, excluded them from the analyses. As described above, this was true for six participants. Finally, we checked how correctly participants recalled the eight digits and, following Gilbert and Hixon (1991), were prepared to exclude participants with four or more mistakes from the analyses. However, none of the participants had four or more mistakes. A total of 32 participants recalled all digits correctly, while six participants made one mistake, two made two mistakes, and two made three mistakes.[12]

To test the effect of responsibility, cognitive load, and their interaction on the number of targets that were written down, we conducted a two-way ANOVA. To test the effect of the same variables on the alarm reaction, we conducted a binary logistic regression analysis, due to the binary structure of that outcome variable. To test the moderation effects of personality on the relationship between responsibility, cognitive load, and their interaction on the one hand and the safety outcomes on the other hand, we conducted multiple linear regression analyses for the number of targets, and multiple logistic regressions for the alarm reaction, adding personality and interactions as factors.

Results

Table 4.1 presents the means, standard deviations, and correlations of all study variables.

[12] Interchanging two digits or not recalling a digit causing the following digits to be shifted was considered one mistake each.

Table 4.1

Means, Standard Deviations, and Correlations of Study Variables

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age	20.92	3.86																		
2. Gender[a]			−.38**																	
3. Experimenter			.28**	−.11																
4. Student[b]			−.64**	.39**	−.29**															
5. Psychology student[c]			.44**	−.25*	.12	−.54**														
6. Room 1[d]			.13	.03	−.23*	−.12	−.03													
7. Room 2[d]			−.03	−.02	.04	.04	−.15	−.51**												
8. Room 3[d]			−.02	−.09	.11	.01	.08	−.31**	−.20											
9. Room 4[d]			.03	.08	−.12	.04	.16	−.09	−.06	−.04										
10. Room 5[d]			−.04	−.11	.03	.06	.15	−.16	−.11	−.06	−.02									
11. Responsibility[e]			−.05	−.04	−.06	.14	−.08	.07	−.04	.06	−.11	−.06								
12. Cognitive load[f]			−.09	.15	−.12	.18	−.20	.21*	−.18	.03	−.10	.08	−.05							
13. Conscientious-ness	3.25	0.69	−.15	.38**	−.09	.08	−.02	.09	.04	−.07	−.11	−.08	−.01	.01						
14. Agreeableness	3.94	0.53	−.08	.33**	.03	.24*	−.19	.09	−.03	−.20	.04	−.10	−.03	.24*	.22*					
15. Neuroticism	3.06	0.75	.00	.20	.04	.08	−.01	.14	−.11	−.09	.11	−.11	−.17	.15	−.07	.08				
16. Openness	3.58	0.75	−.07	.02	.12	.07	−.30**	.13	−.08	.07	.11	−.13	−.12	.06	−.10	.19	.17			
17. Extraversion	3.49	0.66	.06	.19	−.01	.03	−.06	−.01	.08	.03	.05	−.18	.02	−.03	.05	.22*	−.39**	.21*		
18. Targets	6.27	1.49	−.10	.00	.03	−.01	.19	−.18	.16	.10	.05	−.03	.01	−.19	−.01	−.14	.04	−.07	.05	
19. Alarm reaction[g]			−.10	.02	−.02	.11	.03	−.03	−.01	−.01	.14	−.05	.07	.07	.03	.17	.03	−.05	−.01	−.01

Table 4.1

Means, Standard Deviations, and Correlations of Study Variables

Note. $N = 93$ (pooled imputed data).

[a] Gender is coded 1 for males and 2 for females. [b] Student is coded 0 for non-students (working / finished with studies) and 1 for students (of all study years). [c] Psychology students are coded as 1 and other students or participants not studying are coded as 2. [d] The room variables are dummy-coded, such that 1 refers to experiments conducted in the respective room and 0 in any of the other rooms. [e] Low responsibility is coded as 0 and high responsibility as 1. [f] No cognitive load is coded as 0 and cognitive load as 1. [g] No reaction to the alarm (reflecting high safety compliance) is coded as 0 and a reaction to the alarm (reflecting low safety compliance) is coded as 1.

* $p < .05$, ** $p < .01$ (2-tailed).

Impact of Responsibility and Cognitive Load on Safety Performance and Compliance

Table 4.2 presents the means and standard deviations of registered targets and alarm reactions as a function of responsibility (low/high) and cognitive load (yes/no).

Table 4.2

Means and Standard Deviations of Correct Targets Indicated and Frequencies of Alarm Reactions as Functions of Responsibility and Cognitive Load

	DV: Targets[a]			DV: Alarm reaction[b]		
	Low responsibility	High responsibility	Overall mean	Low responsibility	High responsibility	Overall mean
No cognitive load	6.46 (1.10)	6.59 (1.34)	6.53 (1.22)	30.4%	34.5%	32.6%
Cognitive load	6.05 (1.46)	5.85 (2.01)	5.95 (1.72)	33.4%	45.0%	38.9%
Overall mean	6.26 (1.29)	6.28 (1.68)	6.27 (1.49)	31.8%	39.0%	35.2%

Note. DV = Dependent variable. $N = 93$ (pooled imputed data). low responsibility – no cognitive load $n = 24$, low responsibility – cognitive load $n = 22$, high responsibility – no cognitive load $n = 27$, high responsibility – cognitive load $n = 20$.

[a] Targets = Mean number of correct targets indicated, with a maximum of 8; standard deviations are within parentheses. [b] Alarm reaction: Percentage of participants who reacted to the alarm.

The two-way ANOVA with the number of correctly indicated targets as dependent variable revealed *neither* a significant main effect of responsibility ($F(1, 89) = 0.01$, $p = .92$, $\eta_p^2 = .00$), nor of cognitive load ($F(1, 89) = 3.48$, $p = .07$, $\eta_p^2 = .04$). Additionally, the interaction between responsibility and cognitive load on the number of correctly indicated targets was *not* significant either ($F(1, 89) = 0.28$, $p = .60$, $\eta_p^2 = .00$). Thus, Hypotheses 1a, 2a, and 3a were *not* supported.

The logistic regression analysis with participants' reaction to the alarm as distractor revealed *no* significant association between reaction to the alarm on the one hand and neither responsibility ($b = 0.19$, $SE = 0.61$, $p = .76$), nor cognitive load ($b = 0.13$, $SE = 0.68$, $p = .85$) on the other hand. Moreover, the interaction between responsibility and cognitive load on the alarm reaction was not significant either ($b = 0.31$, $SE = 0.91$, $p = .74$). The overall model fit was Nagelkerke pseudo $R^2 = .02$. Thus, *no* support was found for Hypotheses 1b, 2b, and 3b.[13]

Interaction with Personality

Table 4.3 presents the results of the regression analyses (for correctly indicated targets) and logistic regression analyses (for the alarm reaction) predicting the dependent variables from responsibility, cognitive load, the personality traits, and all possible interactions between the latter three. Concerning conscientiousness and agreeableness, all interactions were non-significant. Thus, hypotheses 4a, b, c and 5a, b, c were not supported. Concerning neuroticism, openness, and extraversion, all interactions for correctly indicated targets were non-significant, too, yielding *no* support for Hypotheses 6aa, ba, ca and 7aa, ba, ca. However, interactions occurred for the alarm reaction. These interactions are discussed hereafter, while the non-significant findings are presented in Table 4.3.[14]

[13] The results with those participants who may have received an oral instruction not matching the responsibility condition excluded from the analyses led to very similar results and the same conclusions.

[14] The results with those participants who may have received an oral instruction not matching the responsibility condition excluded from the analyses led to very similar results and in most cases the same conclusions. Differences in conclusions are given in footnotes.

Table 4.3

Regression Analyses Predicting Correctly Indicated Targets and Logistic Regression Analyses Predicting Alarm Reaction, Each as Functions of Responsibility, Cognitive Load, Personality Traits, and Interactions Between Them

		DV: Targets[a]			DV: Alarm reaction[b]		
Model	Predictors	*b (SE)*	*p*	R^2	*b (SE)*	*p*	$\overline{NR^2}$[c]
1	Responsibility	0.07 (2.13)	.97	.05	−0.61 (3.07)	.84	.08
	Cognitive load	−0.69 (2.26)	.76		−3.34 (3.36)	.32	
	Conscientiousness	−0.18 (0.49)	.71		−0.63 (0.74)	.39	
	Responsibility x Cognitive load	−2.11 (3.08)	.49		−0.77 (4.54)	.87	
	Responsibility x Conscientiousness	0.01 (0.64)	.98		0.23 (0.95)	.80	
	Cognitive load x Conscientiousness	0.08 (0.68)	.90		1.07 (1.03)	.30	
	Responsibility x Cognitive load x Conscientiousness	0.55 (0.92)	.56		0.32 (1.38)	.82	
2	Responsibility	0.56 (2.79)	.84	.08	5.45 (4.47)	.22	.12
	Cognitive load	−0.34 (4.03)	.93		−5.28 (7.87)	.50	
	Agreeableness	−0.01 (0.53)	.99		0.99 (0.88)	.26	
	Responsibility x Cognitive load	5.05 (5.45)	.36		−2.86 (9.69)	.77	
	Responsibility x Agreeableness	−0.11 (0.72)	.88		−1.36 (1.13)	.23	
	Cognitive load x Agreeableness	−0.02 (1.00)	.99		1.25 (1.87)	.50	
	Responsibility x Cognitive load x Agreeableness	−1.31 (1.35)	.33		0.87 (2.34)	.71	
3	Responsibility	−0.28 (1.86)	.88	.05	−1.25 (2.90)	.67	.14

Table 4.3

Regression Analyses Predicting Correctly Indicated Targets and Logistic Regression Analyses Predicting Alarm Reaction, Each as Functions of Responsibility, Cognitive Load, Personality Traits, and Interactions Between Them

		DV: Targets[a]			DV: Alarm reaction[b]		
Model	Predictors	*b (SE)*	*p*	R^2	*b (SE)*	*p*	$\overline{NR^2}$[c]
	Cognitive load	−0.84 (1.95)	.67		−1.52 (3.49)	.66	
	Neuroticism	0.08 (0.38)	.84		0.35 (0.57)	.54	
	Responsibility x Cognitive load	0.76 (2.84)	.79		9.97 (5.15)	.053	
	Responsibility x Neuroticism	0.14 (0.61)	.82		0.47 (0.93)	.61	
	Cognitive load x Neuroticism	0.11 (0.58)	.85		0.41 (0.98)	.68	
	Responsibility x Cognitive load x Neuroticism	−0.33 (0.90)	.71		−3.19 (1.63)	.05	
4	Responsibility	1.43 (2.19)	.52	.10	7.19[d] (3.67)	.0503	.10
	Cognitive load	1.77 (2.39)	.46		4.06 (4.37)	.35	
	Openness	−0.04 (0.50)	.94		1.04 (0.83)	.21	
	Responsibility x Cognitive load	−6.44 (3.16)	.04		−7.90 (5.35)	.14	
	Responsibility x Openness	−0.36 (0.61)	.56		−1.98 (1.01)	.05	
	Cognitive load x Openness	−0.56 (0.64)	.38		−1.10 (1.13)	.33	
	Responsibility x Cognitive load x Openness	1.70 (0.87)	.054		2.33 (1.43)	.10	
5	Responsibility	2.11 (2.80)	.45	.06	8.58[d] (5.01)	.09	.28
	Cognitive load	−0.18 (2.91)	.95		−0.35 (4.22)	.93	
	Extraversion	0.31 (0.68)	.64		−0.01 (0.98)	.99	

Table 4.3

Regression Analyses Predicting Correctly Indicated Targets and Logistic Regression Analyses Predicting Alarm Reaction, Each as Functions of Responsibility, Cognitive Load, Personality Traits, and Interactions Between Them

		DV: Targets[a]			DV: Alarm reaction[b]		
Model	Predictors	*b (SE)*	*p*	R^2	*b (SE)*	*p*	$\overline{NR^2}$[c]
	Responsibility x Cognitive load	−2.41 (3.61)	.51		−15.85 (6.61)	.02	
	Responsibility x Extraversion	−0.57 (0.79)	.48		−2.45 (1.44)	.09	
	Cognitive load x Extraversion	−0.07 (0.83)	.94		0.14 (1.20)	.91	
	Responsibility x Cognitive load x Extraversion	0.60 (1.02)	.56		4.68 (1.88)	.01	

Note. DV = Dependent variable; *N* = 93 (pooled imputed data).
[a] Targets: Mean number of correct targets indicated, with a maximum of 8. [b] Alarm reaction: No reaction to the alarm (reflecting high safety compliance) is coded as 0 and a reaction to the alarm (reflecting low safety compliance) is coded as 1. [c] $\overline{NR^2}$ = Nagelkerke pseudo R^2, averaged across the imputed datasets. [d] When excluding the participants who may have received an oral instruction not matching the responsibility condition from the analyses, a significant main effect of responsibility on the alarm reaction occurs in model 4 (model with openness; b = 10.39, p = .02) and model 5 (model with extraversion; b = 10.60, p = .05).

Neuroticism

The interaction between neuroticism and responsibility was *not* significantly related to the alarm reaction (b = 0.47, p = .61), and neither was the interaction between this personality trait and cognitive load (b = 0.41, p = .68). Thus, we found no support for Hypotheses 6ab and 6bb.

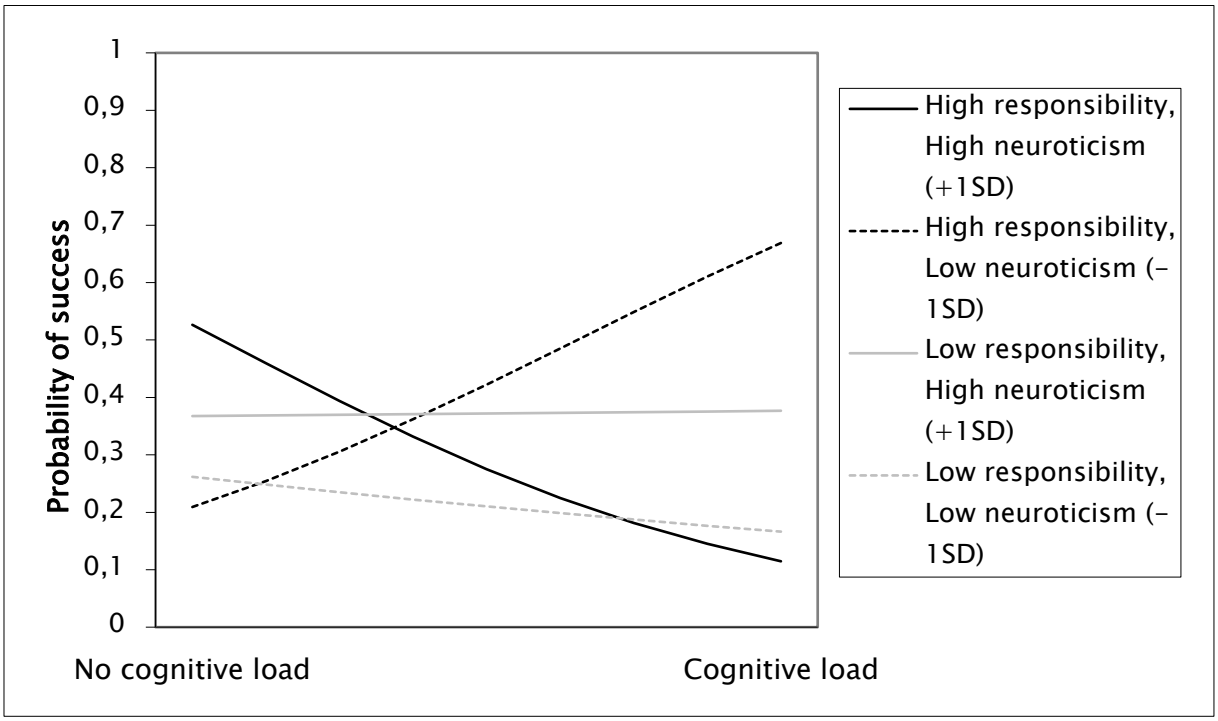
The three-way interaction between neuroticism, responsibility, and cognitive load was significant for the alarm reaction (b = −3.19, p = .05).[15] Figure 4.2

[15] There was no significant interaction (only marginally significant) between neuroticism, responsibility, and cognitive load on the alarm reaction when participants who may have received an oral instruction not matching the responsibility condition were excluded from the analyses (b = −3.10, p = .07).

illustrates this interaction. However, simple slope analyses showed that the two-way interaction was *not* significant at a high level of neuroticism (i.e., $M + 1SD$; $b = -2.19$, $p = .18$) and neither at a low level of neuroticism ($b = 2.61$, $p = .13$). Thus, no support was found for Hypothesis 6cb.

Figure 4.2

Three-Way Interaction Between Neuroticism, Responsibility, and Cognitive Load on Alarm Reaction



Note. -1SD = 1 standard deviation below mean; +1SD = 1 standard deviation above mean.

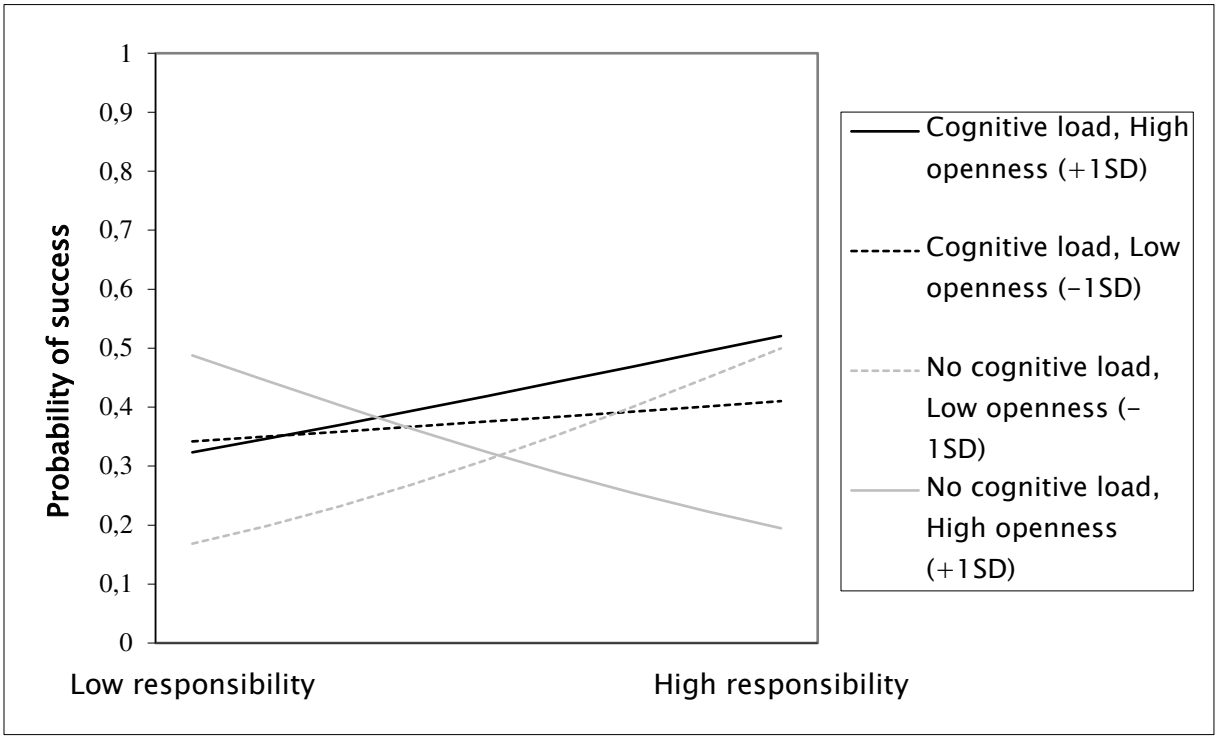
Openness

The interaction between openness and responsibility for the alarm reaction was significant ($b = -1.98$, $p = .05$) and is displayed in Figure 4.3. However, this relationship was neither significant at an openness level one standard deviation

below the mean (b = 1.59, p = .12)[16], nor at an openness level one standard deviation above the mean (b = -1.36, p = .16).

Figure 4.3

Two-Way Interaction Between Openness and Responsibility on Alarm Reaction



Note. -1SD = 1 standard deviation below mean; +1SD = 1 standard deviation above mean.

The interaction between openness and cognitive load on the alarm reaction outcome was *not* significant (b = -1.10, p = .33), and neither was the three-way interaction between openness, responsibility, and cognitive load (b = 2.33, p = .10).

Extraversion

The interaction between extraversion and responsibility was *not* significantly related to the alarm reaction (b = -2.45, p = .09), and neither was the interaction

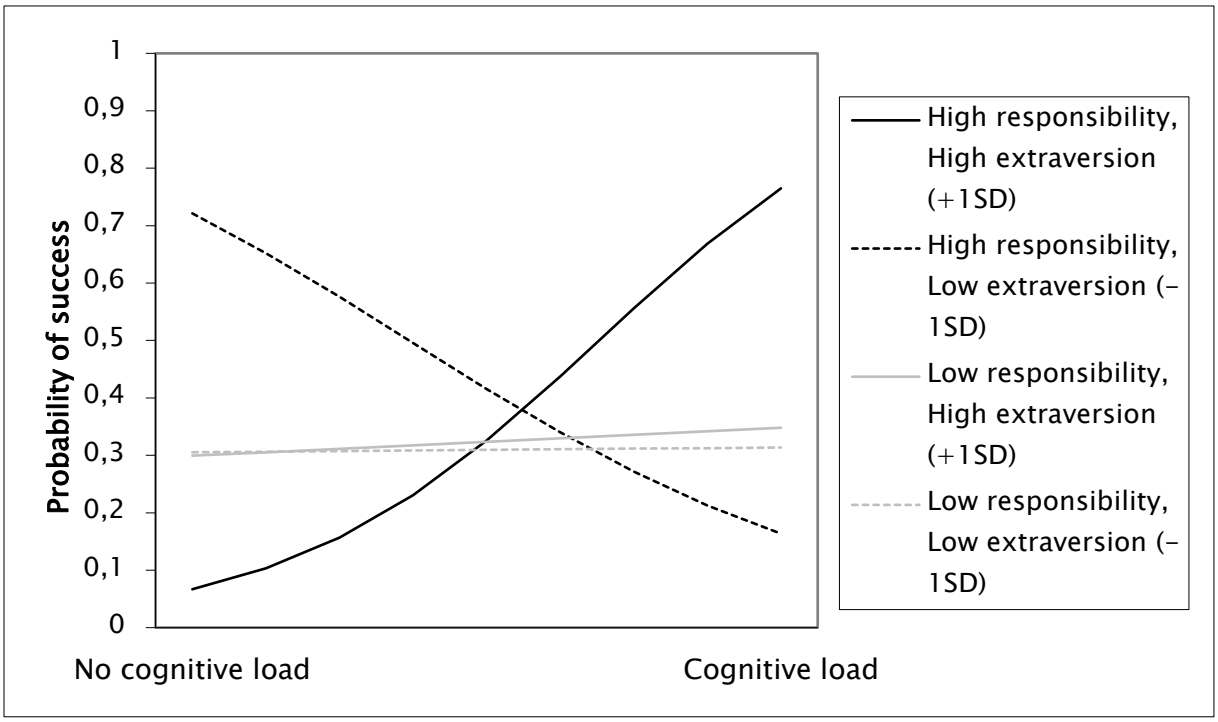
[16] The effect of responsibility on the alarm reaction under low openness was significant when excluding participants who may have received an oral instruction not matching the responsibility condition (b = 2.71, p = .03).

between this personality trait and cognitive load (b = 0.14, p = .91). Thus, we found no support for Hypotheses 7ab and 7bb.

However, the three-way interaction between extraversion, responsibility, and cognitive load was significant for the alarm reaction (b = 4.68, p = .01). Moreover, the interaction between responsibility and load was significant (b = -15.85, p = .02). Figure 4.4 graphically displays these interactions. Simple slope analyses showed that the interaction between responsibility and cognitive load was *not* significant for low extraversion (b = -2.62, p = .10), but was significant for high extraversion (b = 3.59, p = .03). Specifically, for high extraversion, cognitive load leads to *lower* safety compliance for high (but not low) responsibility (see Figure 4.4). This is contrary to our expectations and as such, we found no support for Hypothesis 7cb.

Figure 4.4

Three-Way Interaction Between Extraversion, Responsibility, and Cognitive Load and Two-Way Interaction between Responsibility and Cognitive Load on Alarm Reaction



Note. -1SD = 1 standard deviation below mean; +1SD = 1 standard deviation above mean.

Discussion

The purpose of the current study was to examine the role of situational features that would jeopardize or enhance safety compliance and performance. That is, even though people may have excellent knowledge, skills, and motivation to behave safely, this may not always result in actual safety behavior. More specifically, we investigated the impact of two situational factors, perceived responsibility for safety and cognitive load, on individuals' safety behavior and safety performance. We hypothesized that these two situational factors are each important for safety, but also that perceived responsibility buffers the negative effects of cognitive load. Moreover, we investigated the moderating role of the Big Five personality traits. That way, we considered individual differences and investigated the interaction between situation- and person-factors. Summarizing, we found *no* support for our hypotheses.

Theoretical Implications

Even though the hypotheses were generally not supported, a key implication can be derived from our approach of applying findings from the ethics literature to the safety literature. The safety literature could extend its scope and knowledge by drawing from the ethics literature, especially in terms of an experimental social psychology approach that has largely been neglected in the safety literature thus far. The overall goal should be to integrate an experimental social psychology approach (focusing on why "good people" behave unsafely) and a traditional management approach (focusing on how to manage employees such that they behave safely). This has been done in the ethics literature, where the integration of behavioral ethics (closely related to an experimental social psychology approach) and business ethics (closely related to the traditional management approach) has been termed *behavioral business ethics* (De Cremer & Moore, 2020).

Responsibility and Safety

We found that high perceived responsibility for safety (vs. low responsibility) did not lead to more safety compliance or safety behavior. This is unexpected, as perceived responsibility is generally considered to increase ethical behavior (Treviño et al., 2014). Yet, our findings are coherent with research on job demands and safety. Having high levels of responsibility in one's job can be considered a challenge stressor (Nahrgang et al., 2011). Generally, challenge stressors are unrelated to safety behavior and performance, as confirmed by meta-analytical research (Clarke, 2012). Clarke (2012) explained this finding by referring to two opposing effects. Besides the positive effects of challenge stressors, namely an increased attentiveness that is important for safety compliance, negative effects are at stake, namely strain and anxiety. An important difference between Clarke's (2012) and our research is that we investigated the situational momentary influence of responsibility, while the research of Clarke (2012) referred to general stressors in the workplace. Yet, similar with these findings, situational perceived responsibility, while increasing individuals' attentiveness, may also induce strain and anxiety. These opposing effects may eventually lead to a neutral relationship between on the one hand responsibility for safety and on the other hand safety compliance and performance.

This is in line with the finding of Ladouceur and colleagues (1995) that perceived responsibility was not related to the performance in a pharmaceutical pill classification task. In their experiment, participants with high perceived responsibility felt more anxiety and showed more hesitations, thus supporting the proposition that the negative strain effects of felt responsibility may negate its positive effects.

Cognitive Load and Safety

"When people do too many things at once, they often do some of them badly" (Gilbert & Osborne, 1989, p. 946). This has been empirically validated by the negative impact of cognitive load on various behaviors and performances (Allred et al., 2016; Gilbert & Osborne, 1989). However, our findings imply that this may not hold true concerning safety behavior and performance. Possibly, safety is deemed so important that cognitive load has less of an impact.

Moreover, as the surveillance task in our experiment was little demanding and may even have evoked boredom, an additional task requiring cognitive capacity (i.e., the cognitive load manipulation) may have had a positive impact on safety counteracting the negative effect of cognitive load. Indeed, work underload and boredom can be detrimental for safety behavior and performance (Zacharatos et al., 2005). Following this reasoning, the additional task may not have been equivalent with a hindrance stressor (as argued for by us), but rather a challenge stressor. If that was the case, our results are in line with Clarke's (2012) meta-analytical findings that while hindrance stressors are negatively related to safety behavior, challenge stressors, amongst which work overload, are not related to safety behavior.

Additionally, cognitive load is not only related to aspects that may increase safety behavior and performance, such as being more impatient and making more mistakes, but also to increased risk aversion, which may oppose the negative influence by increasing safety behavior and performance (Allred et al., 2016). Similarly, cognitive load may also lead to increased prosociality in economic games (Peysakhovich & Rand, 2015) and resource allocation tasks (Roch et al., 2000; Schulz et al., 2014); yet findings in that respect are mixed (Hauge et al., 2016). Cognitive load may also lead to prosociality in safety contexts, which would translate into an

increased effort to be safety compliant and safety performant. This effect may counteract negative effects of cognitive load to lead to null-results.

Our findings are also congruent with findings of Hauge et al. (2016), who found no effect of cognitive load on moral behavior. In line with their reasoning, a possible conclusion of our results may be that behaving safely compliant and performant on the one hand and behaving in accordance with self-interest (i.e., doing other things than the safety-related task) on the other hand may be equally as much automatically processed.

Finally, our findings are not in line with findings concerning negative effects of ego depletion on ethical behavior. Yet, Fischer et al. (2012) found that that only ego-depletion but not cognitive load was related to an increase in risk-taking. Thus, cognitive load may not have the same impact as ego-depletion on safety behavior and performance, and therefore it seems to be important to more clearly distinguish between ego-depletion and cognitive load.

Yet, it is important to point out that the impact of cognitive load on safety performance was marginally significant. Thus, it may still be that cognitive load is detrimental for safety performance.

Interaction Between Cognitive Load and Responsibility

In line with findings in the ethics literature, we expected that cognitive load would only be related to safety compliance and performance if the perceived responsibility is low, but not when it is high. However, we did *not* find any support for this moderating role of responsibility. Given our finding that neither cognitive load nor responsibility are related to safety compliance and performance and given our reasoning why this may be the case, it is not unexpected that we found no support for an interaction. First, while the attentiveness evoked by responsibility may counteract the negative influence of cognitive load, the anxiety evoked by responsibility may amplify the negative impact of cognitive load. Second, cognitive

load seems to be unrelated to safety compliance and performance, leaving no opportunity for responsibility to moderate this relationship.

Our null-findings are congruent with findings of Hauge et al. (2016). They found no support for an interaction between cognitive load and the framing of a decision or situation. Our responsibility manipulation is similar to a different framing of the situation in the low versus high responsibility condition.

Moderating Role of Personality

Individuals' personality traits indeed moderated the relationships between responsibility, cognitive load, and their interaction on the one hand and safety compliance and performance on the other hand only to a limited amount. This is not surprising given the non-significant finding regarding responsibility, cognitive load, and their interaction and the possible reasons for these results given above.

On the other hand, neuroticism, openness, and extraversion did show moderating effects on one of the relationships each. Thus, the current study suggests that situation-person interactions play a role in safety compliance. Neuroticism moderated the interaction between cognitive load and responsibility on safety compliance in a surprising way. For neurotic individuals, under high (but not low) responsibility, cognitive load seemed to increase safety compliance. On the other hand, for emotionally stable individuals (individuals low on neuroticism), under high (but not low) responsibility, cognitive load seemed to decrease safety compliance. In the experiment, safety compliance was operationalized as not reacting to a distractor. It may be that the combination of cognitive load and responsibility was so stressing for neurotic individuals that they became passive and therefore showed less reactions to the alarm, which we erroneously interpreted as safety compliance. While the two-way interactions were not significant to further substantiate these relations, the relation of cognitive load, responsibility, and neuroticism is intriguing and warrants a closer examination.

Concerning openness, we found that while for individuals high in openness, high (vs. low) responsibility seemed to lead to lower safety compliance, for individuals low in openness, high (vs. low) responsibility seemed to lead to higher safety compliance. Individuals high in openness may react to responsibility with non-compliance as they want to restore their feeling of autonomy, question authority, and seek sensation (Beus et al., 2015). On the other hand, individuals low in openness have less of these needs and react to responsibility with the generally expected increased safety compliance. Even though the two-way interactions were not significant to further substantiate these relations, the interaction between openness and responsibility is interesting and should be further investigated.

For extravert individuals, cognitive load leads to lower safety compliance for high but not low responsibility, while for introvert individuals, the impact of cognitive load does not differ depending on the responsibility. This is surprising, as we did not particularly expect the impact of cognitive load on extravert individuals' safety compliance to be influenced by their felt responsibility, because extraverts usually perform well in demanding tasks (Farmer, 1984, in Lawton & Parker, 1998). A possible explanation is that extraverts invest little effort to counteract the negative impact of cognitive load, especially when they are responsible for safety. Extravert individuals generally behave less safely than introverts (Beus et al., 2015), which may be the case because they seek sensation and thus deliberately violate safety rules (Neal & Griffin, 2004). Thus, when extraverts are responsible for safety, they may take cognitive load as a welcome excuse to behave less safety compliant.

Practical Implications

Researching why individuals behave varyingly safely in different situations helps to identify situational factors that should be avoided and/or that individuals should be aware of to prevent themselves from behaving less safely than according to their standards. Practitioners could also use knowledge of these situational

factors in trainings for employees to increase their awareness and *safety resilience*. Equivalent to *moral resilience* (Yuan et al., 2020), safety resilience can be described as sustained motivation to behave safely.

Our cognitive load manipulation (i.e., rehearsing digits) may not seem relevant to everyday life at first sight, but it mimics "the many resource-consuming tasks of ordinary life" (Gilbert & Osborne, 1989, p. 940). For example, it may reflect doing multiple things at once, regulating one's thoughts, emotions, and behavior, or ruminating / thinking about non-task related things. According to our results, the mentioned activities may not per se impair one's safety compliance or performance.

Likewise, perceived responsibility for safety may be more or less present in the workplace, depending on, for example, supervisors' involvement in safety and delegation of safety-related tasks (Yule et al., 2007), responsibility-inducing job characteristics such as autonomy (Turner & Parker, 2004), and a strong safety climate (Zackowitz, 2001). Yet, our results indicate that increasing individuals' situation-based perceived responsibility for safety may not influence how safety compliant or performant they behave.

Finally, the current study suggests that not all individuals are influenced by cognitive load and responsibility in the same way. Attention for individuals' personality is needed when deciding whom to give responsibility and whom to expose to cognitive load. For example, our results indicate that to achieve high safety compliance of extravert individuals who have a high responsibility for safety, they should not have additional cognitive load.

Limitations and Future Research

An important limitation of the current study is that we did not include a manipulation check for the responsibility manipulation. Therefore, we cannot be sure whether we effectively manipulated responsibility. It may be that we manipulated something else instead, for example perceived importance or, given

the results, nothing at all. Yet, albeit in another context, the responsibility manipulation of Ladouceur et al. (1995) was similar to ours and these authors did find evidence for a difference in perceived responsibility between the conditions. However, they also found differences in perceived probability of, severity of, and influence over negative consequences, which thus may be investigated in future research as possible confounders.

Moreover, the number rehearsal task as cognitive load manipulation, although established in the literature, does "not give consistent results across studies" (Hauge et al., 2016, p. 575) and may not be sufficient to induce enough cognitive load (Gilbert & Hixon, 1991). However, the number rehearsal task was, on average, not perceived as easy by participants and we did exclude participants who did not keep the number in their mind but wrote it down. Still, other ways to manipulate cognitive load may be studied in the future.

Our measurements of safety compliance and safety performance have downsides. Especially in the low responsibility condition, participants may not have regarded their behavior and performance as safety-relevant. Moreover, it is questionable whether reacting to an alarm (only) reflected (safety) non-compliance. It may also have confounded with dedication, devotion, or perseverance of attention. The fact that the measurement of safety compliance was not related to safety performance further indicates that we may not have been measuring safety compliance. Future research may investigate other forms of safety compliance and add safety participation as additional safety behavior. Second, we measured safety performance by correctly indicated targets, which were persons with red garment. Yet, the term "red garment" may not have been sufficiently specific, such that some participants indicated persons with red umbrellas, red bags, or orange garments. Five participants explicitly told the experimenters that they found it difficult to

distinguish red, orange, and pink garments. This may have distorted the results, such that future research should use a more clearly defining characteristic.

Furthermore, the final sample included fewer than the 100 participants that were planned based on the literature. This reduced the power; especially concerning the three-way interaction-tests, the power was probably low. The low power may account for non-significant findings and thus lead to a bias in the results. Moreover, besides the merits of experimental laboratory research, it has the downside of limited external validity. We can thus not generalize our results to other situations and populations. As our sample consisted of mainly psychology students, future research could conduct field research and/or research with employees working in safety-relevant industries.

Another fruitful direction for future research would be to investigate whether other situational factors that are known to influence ethical behavior influence safety behavior and performance, for example gain versus loss framing (Kern & Chugh, 2009). Moreover, it would be valuable to examine underlying processes in the relationship between cognitive load and safety behavior and performance, such as ego depletion. Finally, future research may investigate individual difference variables other than personality. For example, self-efficacy, risk-taking tendencies, and safety attitudes are related to safety (Beus et al., 2016) and may act as moderators for situational factors.

Conclusions

Even though the interest in and research concerning safety behavior and performance is considerable, one category of potential antecedents has been widely neglected, namely situational factors. By delivering the first empirical evidence concerning the impact of situational factors on safety behavior and performance, the current research creates a foundation for an examination of this topic. Moreover, by drawing on the ethical literature and introducing the term *bounded*

safety, the current research forms a starting point for a further integration of the ethics and safety literatures. The current research also indicates the importance of taking into account person-situation interactions when researching safety or trying to increase individuals' safety behavior and performance.

Chapter 5:

General Discussion

Introduction

The aim of this dissertation was to improve the knowledge on several topics in the leadership and safety domain. Therefore, theoretical insights and practical implications were sought concerning how to improve employees' safety behavior and their cognitive task performance, and how to support supervisors in their leadership role. The dissertation focused on the relationship between leadership and employees' safety behavior in air traffic control (ATC, study 1), the relationship between leadership and employees' cognitive task performance (study 2), and situational factors in interaction with personality as antecedents of individuals' safety behavior (study 3). The central themes thus were leadership and safety behavior. These themes (separately as well as their relation) were discussed in further detail in a literature review in chapter 1.

Summary of Key Findings

The first study (chapter 2) investigated the relationship between supervisors' leadership aspects and air traffic safety (ATS) employees' safety behavior in a European air navigation service provider (ANSP). The focus was on supervisors' servant leadership, trustworthiness, leader-member exchange (LMX), and support for safety on the one hand and employees' safety compliance and safety citizenship behavior on the other hand. Drawing on empirical findings from the literature (see also chapter 1) as well as social learning theory and social exchange theory, positive relationships between the leadership and safety behavior aspects were expected. However, the results of the first study indicated that none of the hypothesized relationships was positive. Moreover, contrary to expectations of positive relationships, supervisors' trustworthiness was *negatively* related to ATS employees' safety citizenship behavior. For all remaining relationships, *no* evidence was found. Although these findings need to be interpreted with caution due to the small sample

size, they imply that the specifics of the ATC context (as elaborated on in chapter 1 and 2) may affect the leadership processes at play.

The second study (chapter 3) focused on the most studied leadership styles, namely transformational and transactional leadership, and examined their relationship with employees' cognitive task performance. Drawing on conservation of resources (COR) theory (Hobfoll, 1989), leadership was expected to be related to employees' cognitive performance through increasing employees' resources. However, no support was found for a relationship between neither transformational nor transactional leadership and employees' attention, working memory, and problem-solving performance. The investigated leadership aspects also did *not* interact in their relationship with cognitive task performance, except for one problem-solving task. That specific interaction indicated that transactional leadership might be important for problem-solving if transformational leadership is low. Overall, the results of the second study indicate that the relationship between transformational and transactional leadership and employees' cognitive task performance may be negligible and that COR theory may *not* apply to this relationship.

The third study (chapter 4) elaborated on the role of situational factors for individuals' safety behavior. So far, situational factors have widely been neglected as safety antecedents (see also chapter 1). However, drawing on recent suggestions in the safety literature and bounded ethicality research, situational factors might have a relevant impact on individuals' safety behavior. The term "bounded safety" was introduced in the third study to refer to situational factors that impact individuals' safety behavior even though these individuals generally know how to behave safely, can act safely, and are generally willing to do so. The third study focused on cognitive load and perceived responsibility for safety as situational factors. It investigated their separate and interacting influence on individuals' safety

compliance and safety performance in a surveillance footage detection task. Moreover, individuals' Big Five personality traits were investigated as possible boundary conditions. *No* support was found for a general influence of cognitive load and perceived responsibility for safety on safety compliance and performance. However, depending on individuals' levels of neuroticism, extraversion, and openness, differential influences of the situational factors on safety compliance occurred. The findings of the third study indicate that depending on individuals' personality, situational factors may influence their safety compliance.

Theoretical Implications

While multiple theoretical implications follow from the results of the three studies, this section is restricted to overall implications that are central to this dissertation and relate to at least two of the preceding chapters. This is done to avoid overlap between the individual studies' discussion sections and this general discussion. Additional theoretical implications that relate to the separate studies can be found in each of the studies' discussion sections. Accordingly, in what follows, the relationships between 1) leadership and safety behavior, 2) cognitive performance and safety, and 3) leadership and situational factors are discussed. Moreover, implications concerning the applied theories are given.

Relationship Between Leadership and Safety Behavior

"A large and consistent body of literature has emerged documenting the relationship between organizational leadership and safety outcomes" (Kelloway & Barling, 2010, p. 267). Given the findings of this dissertation, I wish to nuance this statement. I do agree that there is considerable evidence concerning the relationship between leadership and safety (see chapter 1). However, the relationship is complex, has many boundary conditions, and depends on the leadership and safety approaches under study. For example, as the literature review in chapter 1 shows,

many scholars have investigated numerous leadership concepts in relation to safety, including leadership styles, behaviors, relational aspects, and trust(worthiness) perceptions. Moreover, they have studied safety in terms of outcomes such as accidents or incidents, or as numerous behaviors (e.g., the traditional differentiation between safety compliance and safety participation, but also safety citizenship behavior, (un)intentional unsafe behavior or very concrete behaviors, see chapter 1). It is evident from the literature review that the relationship between leadership and safety depends on which of these conceptualizations of leadership and safety are chosen.

Additionally, a wide array of mechanisms may explain the relationship between leadership and safety (see chapter 1), such as: (1) safety climate, (2) mechanisms that relate to (safety) motivation, ability and/or opportunities, (3) leadership-specific mechanisms relating to reciprocation or role modeling and (4) general (work and organizational psychology) mechanisms. The breadth of these mechanisms suggests that the body of literature on leadership and safety is "large", yet far from "consistent".

While most mechanisms have been applied to generally explain why leadership is related to safety behavior, two motivation-based mechanisms differentiated between different leadership aspects and/or safety behaviors. Specifically, transformational leadership is related to employees' safety citizenship behaviors via the promotion self-regulatory focus and intrinsic motivation, while it is related to safety compliance via identified regulation, a form of extrinsic motivation. On the other hand, transactional leadership is related to safety compliance via the *prevention* self-regulatory focus (Conchie, 2013; Kark et al., 2015). These findings indicate that not only the relationship between leadership and safety, but also the mechanisms explaining the relationship depend on the applied leadership and safety aspects.

Besides the previously mentioned mechanisms, chapter 1 also suggested that cognitive task performance might be an important (ATC) safety compliance antecedent. As such, cognitive task performance could be a possible mechanism to explain the relationship between leadership and employees' safety behavior. However, the findings from study 2 indicate that leaders may *not* be able to increase employees' cognitive resources and, therefore, that cognitive task performance may *not* be a mechanism to explain the leadership-safety relationship.

Finally, the literature review showed that the relationship between leadership and safety differs depending on boundary conditions, for example the work context. This aspect gains additional support from the findings of study 1, which suggest that leadership aspects that relate to employees' safety behavior in other industries may *not* play a role in ATC. Contrarily, study 1 suggests that different processes may play a role in the ATC context.

Relationship Between Cognitive Performance and Safety

Although in the schematic overview of the studies of this dissertation (Figure 1.1), studies 2 and 3 are not related, several points of overlap should be mentioned, that indicate a relatedness between cognitive task performance on the one hand and safety compliance and performance on the other. To begin with, while attention is a cognitive task performance category (measured in study 2), safety compliance and performance are very much dependent on attention, as can be illustrated with the outcome measures of study 3. Specifically, study 3 measured how many targets participants correctly indicated (safety performance) and whether participants were impervious to distraction (safety compliance), both of which require sustained attention. As tasks are resource-dependent when performance is influenced by the amount of attention devoted to them (Kanfer & Ackerman, 1989), safety performance and safety compliance were thus dependent on the available cognitive resources of participants. This highlights the importance of attentional and other

cognitive resources for safety compliance and performance, and is in line with evidence mentioned in the introduction. For example, Lawton and Parker (1998) linked poor attention performance and information processing to accidents and risks.

Furthermore, one of the manipulations in study 3 included cognitive load induced by a second task. Inducing additional cognitive load implies reducing a person's available working memory, thereby reducing that person's cognitive performance (Allred et al., 2016). Individuals have only a limited amount of attentional effort capacity (Kanfer & Ackerman, 1989). Consequently, cognitive load induced by an additional task should absorb part of this attentional effort capacity, leaving less capacity to focus on the safety-task at hand. This indicates that the cognitive load manipulation in study 3 affected individuals' attentional effort capacity and working memory, two central cognitive task performance categories (see study 2 in chapter 3). The finding that cognitive load was not related to safety compliance and performance in study 3 may thus also imply that cognitive resources on the one hand and safety compliance and performance on the other hand may not be related. This would, however, be puzzling and contradictory to the mentioned overlap between attention and safety compliance and performance.

From a resource perspective, the findings of study 3 may mean that individuals devote part of their (attentional) resources to off-safety-task related issues anyway, be it another task if it is present, or off-task aspects if no additional task is present. This would also be in line with risk homeostasis theory (Wilde, 1982), which assumes that individuals maintain a target risk level. As such, individuals react to factors that change the risk of a situation by displaying behavior that affects the risk level in the opposite direction to maintain the target risk level (i.e., homeostasis). There is some evidence for this homeostatic proposition as individuals have been shown to increase risky behavior if conditions are increasingly

safe, for example in the driving literature (Ford & Tetrick, 2008). Applying this theory to the context of study 3, individuals maintain a stable target risk level by devoting a certain amount of attention to the safety task. That is, irrespective of whether they have a second task, individuals devote the same amount of attention to the safety task, devoting the remaining 'free' attentional resources either to the second task in case there is one, or to something else if there is no second task. In any case, the relationship between cognitive performance and safety compliance and performance is complex and should be further investigated.

Relationship Between and Interaction of Leadership and Situational Factors

While the relationships between on the one hand leadership (introductory chapter and study 1) and situational factors (study 3), and on the other hand safety behavior were investigated independently from each other, the two pathways may be interrelated. First, situational factors and leadership may influence each other. Indeed, leaders partly determine employees' situational circumstances. For example, leaders may affect employees' cognitive load by adapting the number of tasks they allocate to employees. Moreover, leaders have an impact on employees' perceived responsibility for safety, for example by delegating safety-related tasks (Yule et al., 2007). In addition, situational factors also influence how leaders behave (Vroom & Jago, 2007). For example, Donovan et al. (2018) investigated leadership behavior during a significant mining incident without injuries and found that the "safety leadership behaviors engaged in were adaptive and responsive to situational change" (p. 148). In ATC, Melton et al. (2014) discovered that when a trainee is at work, ATS supervisors of the US Air Force employ coaching leadership during normal operations, while they employ directive leadership during emergency or complex operations (as rated by chief controllers).

Leadership and situational factors may also interact concerning their relationship with employees' safety behavior. Generally, "situations influence the

consequences of leader behavior" (Vroom & Jago, 2007, p. 23). For example, Halverson et al. (2004) found that whether employees' leader perception is impacted by leaders' self-sacrificial behavior depends on whether a situation is characterized by crisis or not. Self-sacrifice refers to "the total/partial abandonment, and/or permanent/temporary postponement of personal interests, privileges, or welfare in the (a) division of labor, (b) distribution of rewards, and/or (c) exercise of power" (Choi & Mai-Dalton, 1998, p. 479). The results of Halverson et al. (2004) revealed that during crisis situations, leaders who showed self-sacrificing behavior were perceived as more charismatic than leaders that did not show self-sacrificing behavior. In non-crisis situations, self-sacrificing behavior had *no* impact on employees' perceptions of leaders (Halverson et al., 2004).

Likewise, leadership may also moderate the impact of situational factors. This can, for example, be derived from the framework of mental workload from Van Acker et al. (2018). Van Acker et al. (2018) propose that leadership moderates both the impact of cognitive work demands on employees' mental workload and the impact of the resulting mental workload on employees' behavior, among which their safety behavior. The authors define mental workload as "a subjectively experienced physiological processing state, revealing the interplay between one's limited and multidimensional cognitive resources and the cognitive work demands being exposed to" (p. 358).

In summary, numerous interrelations between leadership and situational factors exist, both in general and in relation to safety. Therefore, scholars should be aware of possible influences of situational factors on the relationship between leadership and employees' safety behavior. Similarly, leadership may affect situational factors and their influence on employees' safety behavior.

Applied Theories

This dissertation applied social exchange theory (Blau, 1964; Gouldner, 1960), social learning theory (Bandura, 1977, 1986), and COR theory (Hobfoll, 1989). While social exchange theory (Blau, 1964; Gouldner, 1960) and social learning theory (Bandura, 1977, 1986) were applied to hypothesize relationships between leadership aspects and ATS employees' safety behaviors in study 1, the results did not confirm these hypotheses. This suggests that these theories may need to be applied differently in the ATC context. For example, as suggested in the discussion of study 1, colleagues may be more likely to act as role models or social exchange partners than supervisors, and/or the outcomes of role modeling and social exchange may be more stringently directed towards the group instead of more distant safety behaviors. Moreover, study 2 indicated that COR theory (Hobfoll, 1989) may *not* be applicable to cognitive resources of employees as evoked by leadership. Indeed, *no* evidence was found for the hypotheses concerning the relationship between leadership and employees' cognitive task performance that could be formulated drawing on COR theory. This implies that for cognitive resources other mechanisms may apply than for emotional and wellbeing resources.

Practical Implications

"The ultimate goal of workplace safety research should be to translate theory and findings into practice" (Beus & Taylor, 2018, p. 12). Yet, even though safety management is one of the key HR responsibilities, safety research is insufficiently integrated into the HRM practice (Fan et al., 2020). In what follows, therefore, special attention is given to practical implications of the doctoral research.

Which Type of Leadership is Safety-Effective?

Drawing on the empirical evidence summarized in chapter 1, numerous constructive leadership styles and behaviors (general and safety-related), high-

quality relationships between leaders and employees, trust towards leaders, and leaders' safety commitment and norms should be stimulated to increase employees' safety behavior. Contrarily, when looking at the null-findings in studies 1 and 2, one may conclude that practitioners should *not* focus on leadership when wanting to increase ATS employees' safety behavior or employees' cognitive performance. However, the null-results may have occurred due to the small sample sizes in studies 1 and 2, which have undermined the statistical power. It may thus be that while in the general population relationships between leadership on the one hand and employees' safety behavior and cognitive performance exist, the low statistical power did not enable us to uncover these relationships. As such, transactional and transformational leadership may still be important for employees' cognitive performance, and supervisors' servant leadership, LMX, and safety support may be important for ATS employees' safety behavior.

Alternatively, the findings of study 2 may imply that transformational and transactional leadership are not effective when trying to improve employees' cognitive performance. As such, organizations may best aim to increase employees' cognitive performance with other measures, such as computerized cognitive training programs that increase working memory performance (Chan et al., 2018; Diamond, 2013). Furthermore, the results of study 2 suggest that when aiming to increase employees' safety behavior, leadership should *not* focus on increasing employees' cognitive performance.

Similarly, the results of study 1 may also imply that supervisors' servant leadership, LMX, and safety support may currently *not* play a meaningful role for ATS employees' safety behavior. ATC is a complex environment with particularities that may alter the effects of leadership. As Coetzee and Henning (2019) put it: "Air traffic controllers are a unique set of individuals operating in a safety critical environment requiring interaction with and responsiveness to an elevated load of

constantly changing information. The management of such a workforce is often challenging" (p. 1). This leadership challenge may hinder supervisors in their efforts to influence ATS employees. According to the results of study 1, supervisors' trustworthiness may even be detrimental to ATS employees' safety citizenship behavior. This could lead us to the recommendation of not paying attention to ATS supervisors' leadership and discouraging supervisors' trustworthiness, but such a path would be ill-considered. The results of study 1 still highlight the need to clarify and establish the leadership role of supervisors. As in other industries, leadership may be an important antecedent of employees' safety behavior in ATC, but the results of study 1 indicate that the proper conditions need to be instilled to enable ATS supervisors' leadership to affect ATS employees' safety behavior.

How may Safety-Effective Leadership be Achieved and Supported?

Given that leadership could be important in ATC, it is important to discuss how safety-effective leadership may be stimulated and how supervisors may be supported to lead as safety-effective as possible. Generally, focusing interventions on supervisors instead of employees is efficient, as by modifying the behavior of few supervisors, the behavior of many employees may be improved. Moreover, supervisors could improve a wide range of employee behaviors (Zohar, 2002a; Zohar & Luria, 2003).

Empirical evidence concerning antecedents of safety-effective leadership is scarce, but in a study in the construction industry, supervisors indicated that social support (from the organization, managers, and colleagues) and autonomy would be key to promote their engagement in safety-effective leadership. On the other hand, role overload, production demands, formal procedures, and workforce characteristics (subcontractor safety attitudes, low skilled employees, and language problems) hindered supervisors' engagement in safety-effective leadership (Conchie et al., 2013). Similarly, in ATC, increased support from other supervisors, managers,

and from the ANSP they work for, more autonomy, and fewer supplementary tasks and roles may enable supervisors to influence employees' safety behavior.

From interviews with employees from the ANSP where study 1 was conducted, additional opportunities to support supervisors in their role as leaders emerged. The two aspects that were mentioned the most often were: a) leadership training and development and b) increasing supervisors' role clarity and changing their role definition (see chapter 2). The following paragraphs elaborate on these two aspects.

Leadership Training and Development

One suggestion that came forth from the interviews was to organize leadership trainings and/or coaching for supervisors. This is in line with research findings in the construction industry, where supervisors indicated that their engagement in safety leadership was supported by equipping them with the needed knowledge, skills, and tools on how to enact safety-effective leadership and approach employees with safety issues (Conchie et al., 2013). Generally, leadership training and development have shown to be effective in terms of improving perceptions of leadership (Kelloway & Barling, 2010) and impacting employees' behavioral, cognitive, and affective as well as organizational performance outcomes (Avolio, Reichard, et al., 2009). The safety literature, too, shows that leadership interventions positively influence supervisors' leadership and employees' safety behavior (Kelloway & Barling, 2010). A systematic review on intervention studies to strengthen safety cultures, showed that, indeed, interventions focused on leadership styles were among the most effective types of interventions (Aburumman et al., 2019). Many leadership training and development approaches and methods exist, but it is crucial to choose or design them carefully, tailoring them to defined objectives and integrating them with management and HR (Cacioppe, 1998). Although leadership training and development initiatives from the general literature could be applied to the safety and the ATC context, leadership interventions that

have already been proven advantageous for safety are especially relevant. I am aware of three studies that developed and applied leadership interventions at the supervisor-level and examined safety-related outcomes (Gravina et al., 2019; Mullen & Kelloway, 2009; Von Thiele Schwarz et al., 2016). Even though none of these leadership interventions was applied to ATC, they are introduced here as they could serve as inspiration for leadership interventions in ATC.

One possibility to shape mainly safety-specific transactional leadership behaviors is based on *behavior-based safety*, an approach that aims to increase safety behavior and decrease unsafe behavior by observing work practices and trying to modify them by giving appropriate feedback (i.e., reinforcement; Dejoy, 2005). In line with that approach, Gravina et al. (2019) designed a leadership intervention that started with six half-day workshops to educate supervisors about behavior-based safety principles and let them shape projects to improve employees' behavior. After the workshops, the leaders needed to complete the projects based on behavior-based safety principles, while they could still make use of coaching. This leadership intervention was successfully applied at a chemical manufacturing plant and reduced the number of accidents substantially (Gravina et al., 2019).

Mullen and Kelloway (2009) designed a safety-specific transformational leadership training and applied it in a health care context. Their training had positive effects on leaders' safety attitudes, intention to promote safety, and self-efficacy, and employees' perceptions of safety-specific leadership and safety climate. Mullen and Kelloway (2009) also found that these effects were more favorable than the effects of a *general* transformational leadership training. The safety-specific transformational leadership training consisted of a half-day interactive workshop to familiarize leaders with safety-specific transformational leadership theory and develop specific safety-goals in line with transformational leadership (Mullen & Kelloway, 2009).

Von Thiele Schwarz et al. (2016) combined the former two approaches. Their leadership intervention blended transformational leadership training with applied behavior analysis to increase transformational leadership and positive control leadership (i.e., contingent reward and safety self-efficacy). The intervention started with a 360-degree evaluation of and feedback to leaders concerning their leadership behaviors. Subsequently, a 14-day theoretical training block followed, during which leaders received lectures on transformational leadership, applied behavior analysis, and motivational processes. The intervention ended with a practical block, during which leaders applied the acquired knowledge while working on a self-chosen improvement area. The project-execution was accompanied by six day-sessions, during which leaders received feedback and support concerning their improvement project. Von Thiele Schwarz et al. (2016) applied the intervention in the Swedish forest industry and found positive effects on transformational leadership and positive control leadership perceptions as well as safety climate perceptions. The safety climate effects were stronger for leaders who chose a project to improve their leadership skills in comparison to leaders who chose a project that was focused on safety- or performance-improvements.

Besides these three studies focusing on a leadership intervention, Nielsen et al. (2015) applied an integrated safety intervention that *included* a leadership intervention. The intervention started with workshops where the organization, supervisors, and employees discussed safety issues and possible solutions. The supervisors then received a one-hour workshop, during which they received feedback on their safety management performance and familiarized with a model showing associations between perceived management commitment to safety, employee behavior, and accident occurrence. Supervisors also specified safety-related focus areas and activities to improve safety performance, which were followed up during four to five individual coaching sessions, that also focused on

"having safety become a more visible part of the supervisors' role behaviour" (Nielsen et al., 2015, p. 144). As a result of the intervention in two small metal and wood processing enterprises, safety leadership, knowledge, involvement, and behavior, as well as safety representatives' commitment increased in one intervention company, but not in the other. The authors ascribed this difference to the difference in management commitment to the intervention (Nielsen et al., 2015).

Leadership interventions similar to the ones mentioned above could be developed for the ATC context. They may also involve other leadership aspects, like LMX or servant leadership, and teach more concrete leadership behaviors that are supportive for safety and that enable supervisors to approach employees with safety issues. Kelloway and Barling (2010) mentioned three considerations that need to be taken into account when designing leadership interventions for safety, namely: a) specifying the intended intensity/duration of the intervention; b) the need to specify and ideally measure the hypothesized sequence of changes (from changes in leadership behaviors, via changes in employees' perceptions, attitudes, and motivations to changes in employees' behavior); c) the logistic difficulties of evaluating the training. Moreover, the findings of Nielsen et al. (2015) suggest that for leadership-involving safety interventions to be effective, management commitment towards the intervention is crucial. Finally, during the training, leaders should be encouraged to focus on improving leadership skills, as this may result in greater improvements as compared to leaders' focus on safety (or performance), as shown by Von Thiele Schwarz et al. (2016).

Supervisors' Role Clarity and Definition

Another aspect that has been put forward during the interviews in the ANSP was to increase ATS supervisors' role clarity and include leadership to their role definition by optimizing their job descriptions and adding leadership behaviors and responsibilities to them. A main question that ANSPs need to reflect upon is which

role they wish the supervisor to fulfil. Currently, ATS supervisors usually have operational and coordinating tasks, and their job descriptions and trainings scarcely include leadership behaviors and responsibilities. ATS supervisors are also not responsible for ATS employees' (safety) behavior. This conceivably contributes to an environment where ATS employees do not perceive their supervisors as leaders and where supervisors' leadership has little impact on employees' behavior. Thus, clarifying role expectations and extending supervisors' role definition with leadership behaviors and attitudes may help supervisors to fully engage as leaders and encourage ATS employees' safety behavior.

In the literature, adding responsibility for safety and employees' safety behavior to supervisors' role definitions has been found to increase supervisors' safety-leadership (Conchie et al., 2013) and their safety-oriented interactions with employees, consequently increasing employees' safety compliance (Zohar & Luria, 2003). This extension of supervisors' role-definition to include (employees') safety could be achieved by increased organizational safety support and prioritization, for example conveyed in the form of safety-related behavioral change programs (Conchie et al., 2013), or the communication of high safety priority (Zohar & Luria, 2003). Thus, clarifying supervisors' job descriptions and adding leadership aspects to them, in combination with the communication of a high safety prioritization by ANSPs, may clarify supervisors' leadership role and support them to enact safety-effective leadership.

Do Situational Factors Need to be Taken Into Account and How?

Although study 3 did not find evidence for a general influence of perceived responsibility for safety or cognitive load on individuals' safety compliance and performance, these situational factors did interact with personality traits in their impact. As such, situational factors do influence some individuals. Practitioners and leaders should take this into account. For example, employees' safety awareness

and safety resilience (i.e., sustained motivation to behave safely; cf. "moral resilience": Yuan et al., 2020) could be increased by training programs that make employees aware of possible situational influences on their safety compliance and performance. If they are aware of it, leaders may take employees' personality into account, in order to alert employees to situational influences and adapt these influences. As such, leaders may need to adapt their leadership to match individuals' personality and the situation at hand to optimize employees' safety behavior.

Leaders in formal leadership positions usually have the possibility to impact employees' cognitive load and perceived responsibility. For example, by decreasing the number of tasks that they allocate to employees, leaders may decrease employees' cognitive load. Moreover, leaders may delegate responsibility for safety (Mearns et al., 2003) or increase employees' perceived responsibility by being involved in safety and delegating safety-related tasks (Yule et al., 2007), increasing employees' autonomy (Turner & Parker, 2004), or promoting a strong safety climate (Zackowitz, 2001). Leadership may not only influence the extent of cognitive load or responsibility, but may also *moderate* their effects. As such, leaders may try to mitigate the negative effects of cognitive load by giving employees the needed support or encouragement. Indeed, Van Acker et al. (2018) proposed that leadership may decrease the impact of cognitive work demands on employees' mental workload and buffer the negative impact of the resulting mental workload on employees' safety behavior. This is especially relevant if cognitive load cannot be reduced. For example, in ATC, peaks in cognitive load due to emergency or complex traffic situations cannot be avoided. The findings of study 3 suggest that leaders should flexibly use their ability to influence employees' perceived responsibility for safety and cognitive load to match their approach with employees' needs (depending on their personality).

Finally, leaders may take into account the notion of "collective responsibility" as opposed to employees' mere individual responsibility for safety. Indeed, safety may require a collective responsibility approach instead of being conceived as the independent responsibilities of employees and leaders. Pilbeam et al. (2016) argue:

> Compliance is not the sole responsibility of one individual – the safety leader, but rather a collaborative endeavour which requires collective leadership, because of variation in context and diversity in actor abilities and engagement with risk and so safety. Safety compliance is therefore a dynamic process that requires collective rather than individual responsibility. (p. 119)

Strengths and Contributions

Before elaborating on limitations of this dissertation and future research ideas, this section discusses strengths and contributions. This doctoral dissertation added to our knowledge on antecedents of safety behavior in ATC and other industries, with a particular focus on leadership and situational factors. With this, it contributes to the safety and leadership literatures. Reviewing the literature, it becomes clear that the safety literature considers leadership as a safety antecedent much more than that the leadership literature pays attention to safety as an outcome. In their review of the organizational health and safety (OHS) literature, Fan et al. (2020) found that the vast majority of OHS research was published in safety science journals, while only 200 out of 5599 articles (3.6%) were published in business and management journals. This dissertation contributes to safety research from a business and psychology lens in the organizational behavior domain.

Another strength of this dissertation is that it is conducted in collaboration with an ANSP. By applying the research to the ATC context and collecting data in an ANSP, the context has been considered as suggested by Mirza and Isha (2017), and the scope of the leadership-safety literature has been broadened. Moreover, this dissertation contributed to bridging the "research-practice gap", which refers to the

phenomenon that research has little impact on management practice and that research is often not inspired by questions and problems of practitioners (e.g., Banks et al., 2016; Sharma & Bansal, 2020; Simsek et al., 2018). A reason for this gap is that researchers and practitioners are guided by different knowledge systems, logics, incentives, motivations, time frames, and discourses (Sharma & Bansal, 2020; Simsek et al., 2018). By engaging with practitioners from the collaborating ASNP to define the research question, shape the method and data collection, and interpret the results, the conducted research (especially that of study 1) had an increased practical relevance (Simsek et al., 2018) and ecological validity. The findings of study 1 were also presented to and discussed with numerous employees with different functions in the ANSP and co-created practical recommendations for the ANSP based on the results, subsequent discussions, and considerations of the relevant literature. This indicates the practical impact of the dissertation.

Moreover, a broad range of theories was involved and applied, namely social exchange theory (Blau, 1964; Gouldner, 1960) and social learning theory (Bandura, 1977, 1986) in study 1 and COR theory (Hobfoll, 1989) in study 2, as well as insights from other literature streams (i.e., ethical literature) in study 3. Even though this eclectic approach hampers an integration of the different studies, it did enable the dissertation to add to different theories and literature streams. Specifically, the dissertation added to social exchange theory (Blau, 1964; Gouldner, 1960) and social learning theory (Bandura, 1977, 1986) by applying these to the safety context and to COR theory (Hobfoll, 1989) by applying it to cognitive resources in a leadership context. Moreover, the dissertation pointed out common grounds between safety behavior and ethical behavior and advanced the integration of the safety and ethics literatures.

A final strength of this dissertation is that it employs multiple methods. While study 1 applied a diary study design, study 2 used a survey and task performance

tests, and study 3 applied an experimental design. Fan et al. (2020) found that most OHS studies use a survey design (35.7%), while only 2.1% combined a survey design with supplementary data collection (cf. my study 2) and 1.2% used an experimental design (cf. my study 3). A diary study design (cf. my study 1) was not mentioned at all. The current thesis thus adds to the field by employing designs that have been used only to a limited extent so far. Moreover, the methods have particular advantages. For example, the diary study design of study 1 aimed to rule out influences of individual difference variables on the results, took into account that leadership fluctuates on a daily basis (Kelemen et al., 2019), and minimized retrospective biases (Beal & Weiss, 2016). Furthermore, the cognitive task performance measures in study 2 were objective and enabled us to assess implicit and unconscious effects of leadership (Johnson & Steinman, 2009). Finally, the experimental design of study 3 permitted us to derive causal inferences (Scandura & Williams, 2000) and counteracted impression management that is present in self-report safety construct measures (Keiser & Payne, 2019).

Limitations and Future Research

While the individual chapters' discussions mention specific limitations and future research ideas per study, this section elaborates on shared and overarching limitations and ideas for future research.

Methodological Limitations

A recurrent limitation of all three studies pertains to their small sample sizes. Their consistently low statistical power makes the interpretation of non-significant results difficult, as these results may be a consequence of the low statistical power. This limitation needs to be taken into account when interpreting the results and implies the need for replication studies with larger samples.

Moreover, even though the methodologies differ between the three studies, each of them at least partly employs surveys. The use of surveys in organizational and management research is widespread and has advantages, such as relatively low time- and resource-investment of researchers and respondents, and by consequence the possibility to obtain a large amount of data. However, the use of surveys is also criticized due to contaminations such as consistency and common method bias, and social desirability (Podsakoff & Organ, 1986). The latter aspect plays an important role in safety research, as self-reports of, for instance, safety behavior are delicate and may be subject to impression management (Keiser & Payne, 2019). Keiser and Payne (2019) found that "impression management accounts for up to one-third of the variance in workplace safety construct relationships" (p. 453). However, they also reported that effects are typically small and impression management only plays a role in particular situations. For the surveys in this dissertation, the potential impact of impression management was minimized by assuring confidentiality to participants and either collecting data anonymously (study 2 and 3) or assuring the deletion of personally identifying information before the data analyses (study 1; Randall & Fernandes, 1991; Zuber & Kaptein, 2014). Moreover, I collected data as independent third party, assuring that nobody from the employees' organizations had access to the data and only aggregated results were reported, which should also decrease impression management (Keiser & Payne, 2019). Nevertheless, it would be valuable to extend the doctoral research with studies applying other methods, such as observations.

A final methodological limitation is that only linear relationships between leadership and safety were investigated. Yet, in line with findings from Katz-Navon et al. (2020), it would be relevant to further investigate possible curvilinear relationships between leadership and safety.

Study Context and Interfaces

All data collections were conducted in the same, Western-European, country. This has the advantage of controlling for the country context, but has the disadvantage of a limited generalizability. Indeed, national boundary conditions can have a strong impact on safety (Burke & Signal, 2010; Fan et al., 2020). Generally, most of the safety research is conducted in developed, Western countries, highlighting the need for research in developing countries (Fan et al., 2020). This is especially important as the risk of safety accidents and injuries is higher in developing countries. For example, in the aviation industry, the death risk per flight between 2008 and 2017 was 27 times higher in developing countries as compared to developed countries (Barnett, 2020).

Even though all studies were conducted in the same country, the integration of the studies is only possible to a very limited extent, as all studies applied different theories and were conducted in different contexts. While the participants of study 1 were ATS employees, the participants of study 2 were employees of a utilities company's IT-department and a government agency, and the participants of study 3 were mainly (psychology) students. The findings are not simply generalizable to other populations and contexts or sectors. While initially the idea was to conduct at least two of the doctoral studies in an ATC context, practical constraints impeded this possibility. To make the research more applicable to ATC, it would be relevant to investigate the research questions of studies 2 and 3 in an ATC context. This could be done with ATS employees in simulation studies or lab experiments. For the latter, for example, the "Kanfer-Ackerman Air Traffic Controller (ATC) Task" (Kanfer & Ackerman, 1989) could be used. It is "a rule-based, real-time, computer-driven task that simulates some of the activities performed by air traffic controllers" (Kanfer & Ackerman, 1989, p. 666).

Relevant future areas of research also appear at the interfaces of the studies. For example, it is important to examine the relationship between cognitive resources or cognitive task performance (study 2) and safety behavior (studies 1 and 3). Moreover, research is needed on how leadership (study 1) and situational aspects and personality (study 3) may interact in predicting employees' safety behavior. Beus (2020) suggests that an important role for leadership in the safety-domain is to restrict the variability in safety behavior. Thus, leadership may be key in buffering possible situational influences on individuals' safety behavior.

Alternative Leadership Approaches and Topics

It would be worthwhile to take other leadership approaches than those in this dissertation. While this dissertation did study a range of leadership aspects, the breadth of leadership aspects and theories in the literature makes additional research necessary. For example, more knowledge is needed on the influence of destructive leadership forms on employees' safety behavior (Nielsen et al., 2016). Moreover, a team leadership perspective would be relevant to take. Instead of a focus on leader-employee interactions, team leadership is focused on the team as a unit (Morgeson et al., 2010). Indeed, ATS teams act highly interdependently and team performance as opposed to individual performance is essential, emphasizing the importance of a team approach. In a further step, more work to integrate these different leadership approaches would also be welcome.

Furthermore, while supervisors play an especially important role in employees' safety behavior (Hofmann et al., 2017), the influence of leadership at other hierarchical levels as well as informal leadership should be taken into account as well. For example, Pilbeam et al. (2016) criticized that all reviewed studies on safety leadership and safety-related leadership practices "adopted a unitary view of the leader as an individual" (p. 119). They argued for the application of plural leadership approaches, which acknowledge that leadership is dispersed within

organizations and exerts a combined influence by multiple individuals (Denis et al., 2012).

It is also necessary to gain a better understanding of the interactions between (safety) behaviors at different organizational levels affecting safety (Casey et al., 2017; Donovan et al., 2018). This line of investigation would be congruent with a systems approach, which is needed to further investigate the relationship between leadership and safety (Donovan et al., 2018; Donovan et al., 2017; Martínez-Córcoles et al., 2011). As Martínez-Córcoles et al. (2011) put it: "Nowadays, to manage safety we need to understand the different parts of the organization interacting as a whole complex system" (p. 1119). I encourage researchers to take a systems approach and consider various factors affecting safety parallel to and in interaction with supervisor leadership. Besides other leadership sources, HRM aspects could be taken into account, as high-performance work systems are an important antecedent for workplace safety (e.g., Barling et al., 2003; Zacharatos et al., 2005), yet depending on the context may also have a negative relationship with safety (Warmerdam et al., 2018).

Research is also needed on the particularities of the rotating leadership system in ATC, as it is unique. For example, a qualitative study may give insights into safety consequences and advantages of this system as well as boundary conditions that affect the system's effectivity. Finally, given the continuous change of supervisors, it would be worthwhile to investigate whether a spillover effect from one supervisor to another occurs concerning employees' safety behavior. Inness et al. (2010) investigated a spillover for employees with more than one job and found that while transformational leadership at the first job was related to employees' safety participation at that job, it was *not* related to their safety participation at a second job with another leader. Whether this also holds true in ATC, where

employees have different leaders but stay in the same job and circumstances, would be a relevant extension of this research.

Conclusions

Given the importance of air traffic safety, every potential increase of it is worthwhile to pursue. ATS supervisors' leadership may be an avenue to increase air traffic safety in a way that so far has received little attention. Even though this dissertation did not find evidence for a current relationship between supervisors' leadership and ATS employees' safety behavior, this does not necessarily mean leadership is unimportant. Rather, it may indicate that the right circumstances need to be created to allow supervisors' leadership in ATC to enact the influence it does have in other industries. I hope this research stimulates further examinations and advancements concerning leadership in air traffic safety, the relationship between leadership and employees' cognitive task performance, and situational factors influencing individuals' safety behavior.

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