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Do individual differences in perceived vulnerability to disease shape employees' work engagement?

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ABSTRACT

The COVID-19 pandemic posed a significant impact on employees' work outcomes worldwide. However, it remains unclear whether some employees fared worse than others when facing work-related health threats and what role individual differences in vulnerability to disease played in shaping their work experiences. Integrating the evolutionary psychology perspective of the behavioral immune system with Job Demands-Resources Theory, we argue that a fundamental factor in how employees dealt with these threats was the extent to which they perceived themselves as vulnerable to infectious diseases. Employees with higher susceptibility to infectious diseases were predicted to experience heightened workplace safety concerns and engage less with their work. In addition, a health-oriented leadership style was expected to decrease employees' safety concerns and increase their work engagement, especially for the more vulnerable employees. To test hypotheses, we conducted a three-wave field survey and two vignette-based experiments on working adults in the United Kingdom at different stages of the pandemic. Results largely supported our predictions, revealing that employees who felt more vulnerable to infectious diseases were more concerned about their workplace safety, inhibiting their work engagement. We discuss these findings' theoretical and practical implications for promoting a safe and healthy post-pandemic workplace, especially for vulnerable employees.

1. Introduction

The COVID-19 pandemic posed a severe global health threat with significant implications for workplaces. During the pandemic, employees' work experiences significantly changed as safety and hygiene policies were implemented in organizations worldwide to curtail the spread of Coronavirus. Unsurprisingly, an international survey reported that in nine out of ten organizations, employees worked remotely at least some of the time (Gartner, 2020). In line with the World Health Organization's (2020) recommendations, various protective health measures were applied in workspaces to prevent the transmission of Coronavirus, such as regular handwashing, wearing masks, and social distancing.

Despite these measures, experts point out that many health crises, not limited to COVID-19, may disproportionately impact the more vulnerable employees, particularly those with underlying health conditions (International Labour Organization, 2020). At the height of the pandemic in 2021, 3.7 million employees in the United Kingdom alone were considered exceptionally vulnerable (Office for National Statistics, 2021). Accordingly, organizations were urged to take particular care of their most vulnerable employees to create healthy, sustainable, and inclusive workplaces, following policy suggestions in many different countries, such as the United Kingdom (Department of Health & Social, 2021), the United States (Occupational Safety & Health Administration, 2021), and Australia (Business.gov.au, 2022).

So far, few studies have explicitly investigated how vulnerable employees respond to these health threats during the pandemic, even though employees with pre-existing health conditions, such as poor immune system functioning, may have been exceptionally at risk (Centers for Disease Control & Prevention, 2021). Existing research indicates that those with poorer health status are more likely to be absent from and engage less in their work (e.g., Mitchell & Bates, 2011; Van der Feltz-Cornelis et al., 2020). However, research has recently highlighted

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that employees' vulnerability to disease is not only determined by their physical health status but also depends on psychological factors (Stangier et al., 2022). Thus, it is valuable to identify whether differences regarding individual subjective perceptions of vulnerability affect how employees deal with and respond to work-related health threats and crises.

Moreover, what is unknown is how such individual differences in vulnerability influence employees' responses to a health crisis like COVID-19. Scholars have recognized the importance of studying employee work engagement following the onset of the pandemic (e.g., Subramony et al., 2022; Yuan et al., 2021), assuming that employees struggled to stay focused and engaged while working during the pandemic. Importantly, work engagement has recently been suggested as the key to making the transition to the post-pandemic workplace successful (Brockner & van Dijke, 2024; Yuan et al., 2021). Accordingly, an in-depth examination of how individual differences in vulnerability to disease threats shape employees' work experiences, particularly work engagement, is warranted.

Lastly, because managers play a crucial role in creating a healthy and physically safe workplace for their employees and contributing to employee health in general (Kniffin et al., 2021; Kniffin et al., 2021; Rudolph et al., 2020), it is necessary to investigate how leaders can mitigate the outcomes of health threats. Manager safety commitment was an important factor in fostering job engagement among employees returning to work during the pandemic (Yuan et al., 2021). Due to its relevance for workplace safety and employees' health-related perceptions and behaviors, we investigate health-oriented leadership (HOL, Franke & Felfe, 2011), defined as the leader's values toward and awareness of their follower's health and behaviors, such as effective health-related communication and the design of health-promoting working conditions (Rudolph et al., 2020). Although recent studies examined the role of HOL on various employee outcomes (e.g., Günther et al., 2022; Klebe et al., 2021), the conclusions of these studies are somewhat limited because of constraints in research designs (e.g., cross-sectional) and methodology (e.g., the inappropriate conceptualization of the context; cf. Rudolph et al., 2020). Hence, it is useful to re-examine the role of HOL in mitigating the impact of health threats, especially on the more vulnerable employees.

The goals of the current research are three-fold. First, we investigate whether individual differences in perceived vulnerability relate to employees responding to health threats during and beyond the pandemic. We draw on the behavioral immune system theory (BIS; Duncan et al., 2009; Schaller, 2011) to argue that individual differences in vulnerability to infectious disease, known as *perceived infectability*, influence employees' response to health threats and their subsequent work experiences. Second, we integrate the BIS with Job Demands–Resources Theory (JD-R; Bakker et al., 2023; Demerouti & Bakker, 2023; Tuckey et al., 2015) to understand how differences in perceived infectability affect the trade-off between job demands and resources and relate to work engagement. Lastly, we examine whether perceived health-oriented leadership mitigates the adverse effects of perceived infectability on vulnerable employees' work experiences. Taken together, the conceptual model of this research is displayed in Fig. 1.

Our research contributes to the BIS theory by examining vulnerable individuals in the workplace and establishing the relevant role of individual differences in perceived infectability responding to health threats during a pandemic. Our research further contributes to JD-R theory by expanding the scope of job demands to health-related factors (i.e., the risk of being infected while working) and considering physical workplace safety as a vital job resource. Moreover, our research advances work engagement knowledge by identifying individual differences in vulnerability as an important antecedent of work engagement, particularly during a pandemic. Lastly, our research contributes to the literature on occupational health and leadership by critically investigating health-oriented leadership and its relationship to engagement and perceptions of safe and healthy workplaces. From a practical perspective, our research might offer managerial suggestions on recognizing and supporting vulnerable employees and fostering safer, healthy, and inclusive post-pandemic workplaces.

2. Theoretical background and hypotheses development

2.1. Reacting to health threats

The threat of infectious diseases has significantly shaped human cognition and behavior in evolutionary history (e.g., Ackerman et al., 2018; Murray & Schaller, 2016; Schaller & Duncan, 2016). Rooted in evolved psychological systems for disease avoidance, people's beliefs about their susceptibility to infectious diseases play a critical role in calibrating their emotions, cognitions, and behaviors (Duncan et al., 2009; Safra et al., 2021). The Behavioral Immune System (BIS) theory asserts that humans possess a set of psychological and behavioral mechanisms proposed to have evolved through natural selection to prevent them from getting infected and sick (Schaller, 2006). A core idea of BIS theory is that humans have a psychological, behavioral immune system in addition to the physiological immune system (Schaller, 2011; Schaller & Duncan, 2016; Schaller & Park, 2011). When people detect disease threats in their environment, it triggers adaptive emotional (e.g., fear, disgust), cognitive (e.g., beliefs about who carries the disease), and behavioral responses (e.g., social distancing) to prevent infections. Because humans cannot observe these threats or pathogens directly, they rely on various internal (e.g., a chronically weak physiological immune system) and external (e.g., the presence of coughing or sneezing co-workers in a poorly ventilated office) cues to assess the infectability risk.

The COVID-19 pandemic is likely to have activated people's BIS responses, thus inducing a variety of reactions to prevent infections. People who perceive themselves as chronically more vulnerable to infections tend to be more anxious about COVID-19 (e.g., Kempthorne & Terrizzi, 2021), experience the pandemic as more dangerous (e.g., Sica

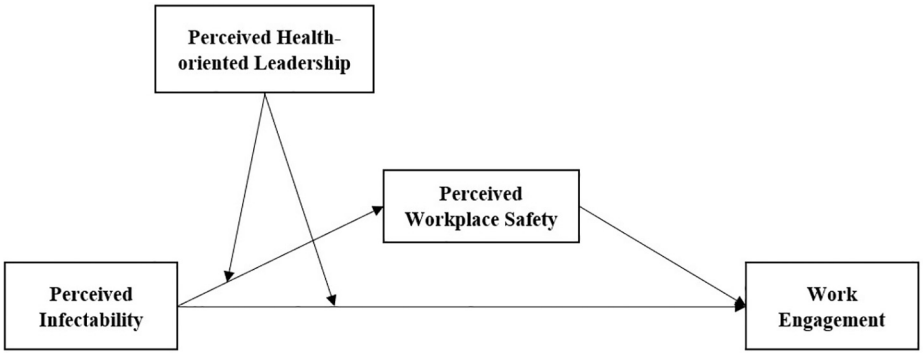

Fig. 1. The conceptual model.

et al., 2021), show greater threat reactivity (e.g., Safra et al., 2021), engage in more protective and vigilant behaviors to avoid the disease (e.g., Makhanova & Shepherd, 2020) and exhibit high vaccination intentions and low anti-vaccination attitudes (e.g., Karlsson et al., 2022; Kempthorne & Terrizzi, 2021).

2.2. Perceived infectability in the workplaces

COVID-19 may activate the BIS among employees, especially when confronted with various infectious disease cues in their workplace. When employees directly interact with co-workers or customers, commute using public transport, or follow the media coverage of the pandemic, they may experience stronger reactions related to heightened BIS activity, resulting in various functional responses. The BIS may also be persistently activated due to individual differences in personality (e.g., neuroticism) or self-assessments of the quality of the immune system, that is, the perceived infectability (e.g., Makhanova & Shepherd, 2020; Schaller & Duncan, 2016). Employees can perceive having a higher or lower infection risk—based on their perception of their physiological immune system, which correlates with actual immune system quality (Schaller, 2011).

According to BIS theory, people take steps to prevent getting infected or reduce the risk of getting infected when confronted with disease cues (Schaller & Park, 2011) that activate the disease avoidance mechanisms (Murray & Schaller, 2016). This assumption also aligns with the Health Belief Model (Jones et al., 2014; Rosenstock et al., 1988), which states that individuals will take preventative actions when they perceive themselves as vulnerable to any disease-related challenge. Both theories have implications for how employees experience work during the pandemic, particularly concerning their *work engagement*, which is "a positive, fulfilling, work-related state of mind characterized by vigor, dedication, and absorption" (Schaufeli et al., 2002, p.74). Meta-analytic and empirical studies have consistently linked work engagement to positive work outcomes, including greater task performance (Christian et al., 2011), lower withdrawal from work (Bakker et al., 2014), and greater compliance with safety procedures (Nahrgang et al., 2011). However, work engagement is also affected by employees' subjective health status (Cook & Zill, 2023), which indicates that health concerns play a role in the motivational process, leading to higher or lower work engagement. Thus, it is important to examine employees' work engagement changes associated with their perceived infection risk during a pandemic (Subramony et al., 2022).

JD-R theory describes working conditions in terms of job demands (all aspects of the job that require sustained physical and/or psychological effort) and job resources (all aspects of the job that motivate, help to achieve goals, and reduce job demands; Bakker & Demerouti, 2017; Demerouti et al., 2001). We draw on this framework to conceptualize the risk of being infected in workplaces as a salient job demand that tends "to be directly associated with personal harm or loss" (Tuckey et al., 2015, p.133), requires increased effort to avoid undesirable outcomes, depletes cognitive and emotional resources, and results in lower engagement (Searle & Tuckey, 2017). The negative relationship between threatening job demands of perceived risks and work engagement is empirically substantiated by a field study (Tuckey et al., 2015) and a meta-analysis (Nahrgang et al., 2011). Further studies have also shown that aging employees who are generally more vulnerable to infections are less engaged with work, especially when observing co-workers who are getting infected (Reinwald et al., 2021; Schaller & Park, 2011). Based on the integration of BIS and JD-R models, we propose that employees who believe they are more vulnerable to getting infected at work will be more likely to subsequently disengage from their work.

H1. Employees' perceived infectability negatively affects their subsequent work engagement.

BIS theory also implies that the activated BIS could trigger a suite of adaptive emotional and cognitive disease-avoidance responses beyond disengagement. Highly infectable employees may be particularly concerned about the perceived likelihood of being at risk of physical harm in the work environments, also known as *workplace safety* (Beus et al., 2016). Thus, they may be likely to pay more attention to procedures in place to avoid infections among co-workers during a pandemic. JD-R theory posits that threatening job demands increase employees' efforts to manage negative emotional and cognitive fallouts. Furthermore, an activated BIS could lead to diminished individual resources (cf. Bakker & Van Wingerden, 2021; Cook & Zill, 2023). Thus, employees at high infection risk may have greater concerns about workplace safety as job resources that could mitigate the health threat. Tuckey et al. (2015) argued that concerns about personal health at work fundamentally threaten employees' safety needs, causing greater work-related stress.

Taken together, we propose that employees at high risk of infections (i.e., job demands) are more concerned about their physical health and safety in workplaces (i.e., job resources), especially during a health crisis. Recent research on COVID-19 offers indirect support for this assumption: Employees who experienced more COVID-19 infection risks preferred to work more remotely instead of spending more time in the office (Shao et al., 2021), whereas fear of getting COVID-19 negatively affects employees' work progress (Trougakos et al., 2020) and increases their psychological distress (Eguchi et al., 2021). Existing evidence thus supports our assumption that employees who generally feel more vulnerable to infectious diseases will upregulate their immediate concerns about workplace safety during and beyond a pandemic.

H2. Employees' perceived infectability negatively affects their perceptions of workplace safety.

According to JD-R theory, safety and health in the work environment create a motivational process in which these job resources motivate employees toward higher work engagement (Bakker et al., 2023; Bakker & Demerouti, 2017). Consistent with this focal assumption, Kahn (1990) argued that workplace safety standards are fundamental for high job engagement. Research has established the JD-R model of workplace safety (Nahrgang et al., 2011), suggesting that a safe work environment fosters employee work engagement (e.g., Rich et al., 2010). Thus, we argue that employees who perceive workplace safety will be more likely to engage in their work subsequently.

H3. : Employees' perceptions of workplace safety positively affect their subsequent work engagement.

Following the logic of BIS, an increase in the risk of getting infected at work should increase employees' concerns about workplace safety, which makes it difficult to continue to devote time and effort to their work (Bakker & Demerouti, 2017; Searle & Tuckey, 2017). JD-R theory also supports this argument and proposes that job demands hinder employee engagement through reduced job resources (Bakker & Demerouti, 2024). Recent research has found that perceptions of COVID-19 risks among employees increased their psychological distress and decreased work engagement (Bakker & Van Wingerden, 2021; Gómez-Salgado et al., 2021), particularly in industries with much direct interpersonal contact (Subramony et al., 2022). Thus, we propose:

H4. Employees' perceived infectability negatively affects their subsequent work engagement via their perceptions of workplace safety.

2.3. Mitigating role of health-oriented leadership

Managers are critical to processes impacting employee engagement and safety perceptions due to their role in safeguarding employees' physical health and safety (Kniffin et al., 2021; Kniffin et al., 2021; Rudolph et al., 2021). Thus, employees' perceived leader behaviors can function as cues for the assessment of their infection risk at work. According to BIS, individuals are expected to react to infectious disease cues such as COVID-19 based on individual cost-benefit analyses (cf. Schaller et al., 2007; Schaller & Park, 2011) and consider their

sensitivity to infection in their risk assessment as well as various working conditions (e.g., open office, poor ventilation). Therefore, organizational cues that imply heightened infection threats should evoke stronger responses, and cues that signal relative workplace safety should lower employees' risk assessment (Ackerman et al., 2018).

JD-R theory proposes leadership to be a key job resource that can alleviate job demands by protecting the health and well-being of employees (Bakker et al., 2023; Bakker & Demerouti, 2017), helping them reduce the increased health-damaging consequences of demands, as well as during a pandemic (Demerouti & Bakker, 2023; Kniffin et al., 2021). Particularly, leaders who engage in health-oriented leadership (HOL) express that they care about employee health and well-being by conveying health-promoting values, creating health awareness in communications, and improving workplace safety standards (Franke et al., 2014; Pundt & Felfe, 2017). Hence, employees perceiving higher HOL should perceive lower work-related health threats during a pandemic crisis, mitigating the impact on perceived workplace safety.

Supervisors who engage in HOL tend to care for employees' health (*value*) and take responsibility for mitigating health risks. Moreover, they are attentive to their employees' health and health-related aspects of work conditions (*awareness*) and engage in securing a healthy workplace, for instance, by offering flexible work and encouraging employees to follow safety and hygiene rules (*behavior*; Pundt & Felfe, 2017). Accordingly, HOL can be crucial in enhancing employee engagement and mitigating negative work experiences, especially when job demands are high (Bakker & Demerouti, 2024). Research carried out during the pandemic also showed that HOL stimulates employees' job performance and reduces their work stress in times of crisis (e.g., Günther et al., 2022; Klebe et al., 2021). We thus propose:

H5. HOL moderates the relationships between employee perceived infectability and perceptions of work engagement (5a) and workplace safety (5b), such that the negative relationships are weaker when HOL is higher versus lower.

Beyond the potential buffering effects of HOL on several undesirable work experiences, HOL can be important for highly infectable employees to help them cope with infectious disease threats in the workplace, and allow them to devote more effort to their work. JD-R theory argues that HOL is associated with a perception of increased job resources, which can reduce job demands that threaten the risk of being infected and thus enhance motivation to work (Grimm et al., 2021; Tummers & Bakker, 2021). Thus, HOL can mitigate the negative effects of perceived infectability on work engagement via heightened workplace safety perceptions. Therefore, we propose:

H6. HOL moderates the indirect effect of perceived infectability on work engagement via perceived workplace safety, such that this negative indirect relationship is weaker when HOL is higher versus lower.

3. Overview of studies

We conducted two studies to test our hypotheses during the COVID-19 pandemic. Study 1 was a three-wave field survey using a large sample of working adults from the U.K. in May 2021, which coincided with a relatively mild phase of the infection rates from the early outbreak in the U.K. In May 2022, during a relatively mild phase of the pandemic in the U.K. (see Fig. 2), we conducted Study 2, a vignette-based experiment. Both studies have different designs and methodologies, which increases the internal and external validity of our findings. Conducting these studies during various "mild" phases of the pandemic enhances our faith in the external validity of our findings. It allows us to generalize the findings to broader workplaces beyond a pandemic.

4. Study 1

4.1. Methods

4.1.1. Participants and procedure

We collected three-wave data in the U.K. at the early "mildest" phase of the COVID-19 outbreak in May 2021. At this time, the weekly change of new confirmed coronavirus cases remained very low and varied from −3.85 % to 9.09 %, while the reinfections rate fell to its lowest level since the pandemic, ranging from 0.98 ‰ to 1.24 ‰. When data was collected, the U.K. had relatively stable infection rates and many employees were returning to their offices.

We collected the data via Prolific recruiting employees in the sample who worked full-time and had a supervisor at work. An a priori power analysis revealed that a minimum sample size of 260 was necessary to detect a medium correlation ($r = 0.30$) with 95 % power and $\alpha = 0.05$; we over-sampled with a 30 % addition, resulting in the final size of 330. The study comprised three surveys, temporally spaced one week apart. The first survey (Time 1) assessing perceived infectability, perceived COVID-19 threats, covariates and demographics, was administered around mid-May. The second survey (Time 2) assessed participants' perceived workplace safety and HOL. At Time 3, we assessed participants' work engagement.

The final sample consisted of 279 employees (84.5 % retention). Participants held various jobs (e.g., administration, technician, and engineer) from various industries (e.g., education, healthcare, and technology). Most of the sample was female (64.9 %), and over half of their supervisors were female (53.8 %). The average age was 36.03 years ($SD = 9.60$). On average, they had been employed for 6.95 years ($SD = 7.28$) and worked with the current supervisor for 2.98 years ($SD = 3.09$). Over half of them (62.4 %) were offered the option to work from home and to interact with colleagues flexibly via face-to-face, remote, or hybrid tools. Most reported that their general health conditions were fair or better (96 %), and only 19.7 % had at least one chronic illness.

4.1.2. Measures

Unless otherwise specified, all scales were rated using a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*; see Appendix A).

Perceived infectability (Time 1). We measured perceived infectability with the seven-item subscale ($\alpha = 0.95$) from the perceived vulnerability to disease (PVD) questionnaire (Duncan et al., 2009). A sample item is "In general, I am very susceptible to colds, flu, and other infectious diseases."

Perception of workplace safety (Time 2). We measured participants' perceived workplace safety during the past week with the adapted five-item ($\alpha = 0.87$) work environment subscale (Cox & Cheyne, 2000). A sample item is "I was strongly encouraged to report unsafe conditions."

HOL (Time 2). We assessed participants' perceived HOL from their supervisors with an adapted 6-item version ($\alpha = 0.94$) from the health-oriented leadership scale (Franke et al., 2014). A sample item is "My supervisor made sure that the topic of health received sufficient attention at the workplace."

Work Engagement (Time 3). We measured participants' work engagement over the past week with the 9-item ($\alpha = 0.93$) Utrecht Work Engagement Scale (Schaufeli et al., 2006; see also Breevaart et al., 2012). A sample item is "I felt bursting with energy at my work."

Control variables. We controlled for participants' gender due to established relationships associated with work engagement (Christian et al., 2011).[1] We also controlled for whether participants had been

[1] We also included age as a control in the analysis. Controlling for age did not change any of the effects. Results continued to support the hypothesized relationship between perceived infectability and work engagement (H1) and its indirect effect through workplace safety (H2–4).

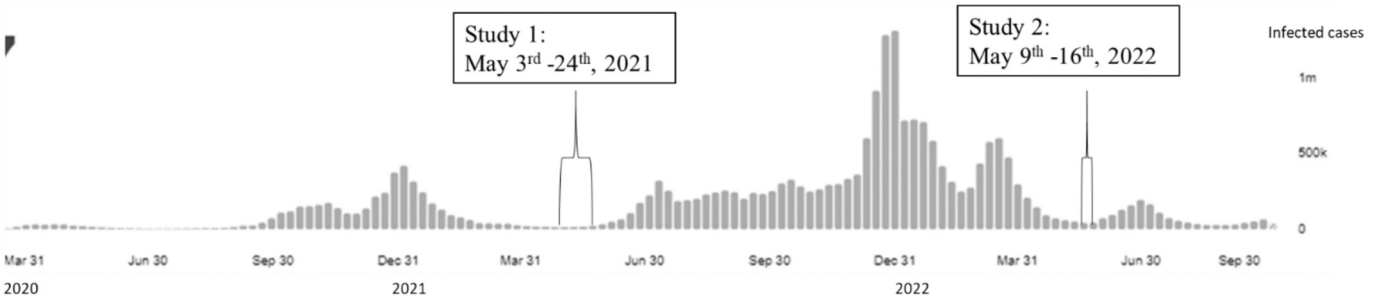

Fig. 2. The trend of coronavarus infections in the United Kingdom between 2020 and 2022. *Note.* The data from "[Cases in United Kingdom]" by the U.K. Health Security Agency. (https://coronavirus.data.gov.uk/details/cases#card-cases_by_specimen_date).

diagnosed with COVID-19 and had received any COVID-19 vaccination at each survey to rule out the possible impact of COVID-19 threats further. In addition, we included chronic illness as a covariate, a potential factor associated with both their health status and work engagement during the pandemic (Cook & Zill, 2023).[2]

4.1.3. Analytic strategy

To test the hypotheses, we employed the ordinary least squares regression and the PROCESS to estimate the confidence intervals of the indirect effects (Model 4) and the conditional indirect effects (Models 8; Hayes, 2017).

4.2. Results

Descriptives and bivariate correlations of our measures are presented in Table 1. We conducted confirmatory factor analyses to examine the discriminant validity among focal constructs by utilizing item parceling for the constructs with more than five measurement items. The hypothesized four-factor model (perceived infectability, HOL, workplace safety, and engagement) shows adequate discriminant validity among study variables, $\chi^2(71) = 112.66$, $p < .01$; CFI = 0.98, TLI = 0.98, RMSEA = 0.05, SRMR = 0.04 (see Appendix C).

Table 2 reports the results from the regression analyses with included covariates. As shown in Model 2, self-reported infectability was negatively related to employees' subsequent work engagement ($b = -0.15$, $p < .05$). Hence, H1 was supported. The Predicted Probability (P—P) plot for the normality of residuals also confirmed this focal hypothesized relationship (see Fig. 3). Results in Model 1 showed that perceived infectability was negatively associated with employees' perceptions of workplace safety ($b = -0.16$, $p < .05$), supporting H2. Model 3 showed that employees' workplace safety perception was positively related to their work engagement ($b = 0.13$, $p < .05$), supporting H3. Model 4 further indicated that the indirect effect of perceived infectability on employees' engagement via their workplace safety perceptions was significant ($b = -0.02$, 95 % CI [−0.049, −0.001]). Therefore, H4 was supported.

To test H5, we ran the moderation analyses for both work outcomes. As shown in Models 6 and 5 of Table 3, the interactions between self-reported infectability and perceived HOL were non-significant for work engagement ($b = 0.04$, $p = .43$) and workplace safety ($b = 0.02$, $p = .70$). Hence, Hypotheses 5a and 5b were not supported. However, HOL positively affected workplace safety perceptions and work engagement. H6 was examined in the moderated mediation analysis, and results revealed no significant conditional indirect effects via workplace safety perceptions on work engagement ($b = -0.001$, 95 % CI [−0.006, 0.007]). Thus, H6 was not supported. Taken together, the findings from Study 1 provided partial support for predictions from the BIS and JD-R models, with the exception of the hypothesized moderating role of HOL.

5. Study 2

Study 2 aimed at replicating the effects of individual differences in perceived infectability on work-related outcomes with a controlled experiment design that allows for the inferences of causality (Hypotheses 1–3). We tested the causality of the hypothesized mechanisms by manipulating both the state of individual differences (infectability) and the work context (workplace safety) in a vignette-based experiment with work engagement as the primary dependent variable. In addition to the general differences of perceived infectability we examined in Study 1, we stimulated infectability at a more dynamic level as temporarily elevated concerns in this study. Because we did not find evidence for a moderating role of HOL in Study 1, we omitted the variable in the second study.

5.1. Methods

We used the parallel design of the experimental mediation approach to provide evidence for causal chains and carried out two randomized studies in parallel (Pirlott & MacKinnon, 2016). We combined a *measurement-of-mediation design* (*the measurement design*, Study 2a) and the *concurrent double randomization manipulation-of-mediator design* (*the manipulation design*, Study 2b). In the measurement design, only the independent variable was experimentally manipulated, whereas the mediator and dependent variables were measured. In the manipulation design, both the independent variable and the mediator were experimentally manipulated (Highhouse & Brooks, 2021; Imai et al., 2013), which aims to investigate mediation as a theoretical analysis by other means than investigating mediation as a statistical analysis (Spencer et al., 2005). The parallel design offers a fairly robust method to infer causal relations concerning the focal mediation-based mechanism in our hypothesized model (Pirlott & MacKinnon, 2016).

5.1.1. Participants

We recruited a sample of British working adults through Prolific at the late stable stage of the COVID-19 outbreak in May 2022. During this period, the weekly changes of new confirmed cases decreased by between 13.68 % and 17.84 %, and the rate of reinfections ranged between 4.77 ‰ and 4.95 ‰.

Following the sampling protocol in Study 1, we targeted a sample of 128 participants detecting a moderate effect size ($f = 0.25$) with 80 % power at α level of 0.05 for a between-subjects factorial design in Study 2a and a sample of 158 participants detecting the same effect size and the power for the 2 × 3 between-subjects factorial design in Study 2b.

[2] We conducted additional analyses on these COVID-relevant control factors to verify inclusion. Results revealed that vaccination buffers highly infectable employees against a lower engagement. We further controlled for participants' general health situation and perceived risk of COVID-19 in each wave. Results showed that exclusion of these controls did not result in meaningful changes for our findings.

Table 1
Means, standard deviations, and bivariate correlations in Study 1.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. Gender (T1)	–	–	(0.95)							
2. Perceived infectability (T1)	3.48	1.35	0.15*	–						
3. COVID infection (T1)	0.57	0.95	0.08	0.22**	–					
4. COVID vaccination (T1)	0.76	0.79	0.01	0.01	−0.03	–				
5. Chronic illness (T1)	0.20	0.40	−0.01	0.32**	0.02	0.30**	–			
6. Workplace safety (T2)	4.96	1.44	0.06	−0.16**	−0.11	−0.09	−0.11	(0.87)		
7. HOL (T2)	4.54	1.39	0.09	−0.07	0.07	−0.04	−0.07	0.41**	(0.94)	
8. Work engagement (T3)	4.30	1.30	0.01	−0.16**	0.09	0.10	−0.07	0.15*	0.36**	(0.93)

Note. $N = 279$. T1 = data collected at Time 1; T2 = data collected at Time 2; T3 = data collected at Time 3. Gender: 0 = male, 1 = female. COVID infection: 0 = not infected, 1 = infected. COVID vaccination: 0 = not vaccinated, 1 = vaccinated with one dose, 2 = fully vaccinated with two doses. Chronic illness: 0 = no, 1 = yes. HOL = health-oriented leadership. Cronbach's alpha values are reported on the diagonal in parentheses where applicable.
* $p < .05$.
** $p < .01$.

Table 2
Results for hypotheses testing in Study 1.

	Model 1			Model 2			Model 3			Model 4		
	Perceived workplace safety			Work engagement			Work engagement			Work engagement		
	(T2)			(T3)			(T3)			(T3)		
Variable	*b*	*SE*	95 % CI	*b*	*SE*	95 % CI	*b*	*SE*	95 % CI	*b*	*SE*	95 % CI
Intercept	5.38***	0.25	[4.884, 5.876]	4.72***	0.23**	[4.264, 5.171]	3.61***	0.30	[3.011, 4.203]	4.10***	0.37	[3.361, 4.829]
Gender	0.25	0.18	[−0.112, 0.604]	0.10	0.16	[−0.219, 0.427]	0.02	0.16	[−0.303, 0.337]	0.08	0.16	[−0.246, 0.398]
COVID infection	1.66	1.43	[−1.154, 4.481]	−0.03	1.30	[−2.583, 2.517]	0.25	1.30	[−2.303, 2.807]	0.14	1.29	[−2.404, 2.674]
COVID vaccination	0.01	0.16	[−0.301, 0.317]	0.24*	0.12	[0.006, 0.479]	0.24*	0.12	[0.007, 0.481]	0.25*	0.12	[0.013, 0.484]
Chronic illness	−0.24	0.23	[−0.684, 0.212]	−0.13	0.21	[−0.540, 0.278]	−0.24	0.20	[−0.634, 0.147]	−0.11	0.21	[−0.512, 0.303]
Perceived infectability (T1)	−0.16*	0.07	[−0.289, −0.023]	−0.15*	0.06	[−0.274, −0.034]				−0.14*	0.06	[−0.256, −0.015]
Perceived workplace safety (T2)							0.13*	0.05	[0.025, 0.238]	0.12*	0.05	[0.008, 0.222]
R^2	0.04*			0.04*			0.04*			0.06*		
Indirect effect										−0.02	0.01	[−0.049, −0.001]

Note. $N = 279$. Gender: 0 = male, 1 = female. COVID infection: 0 = not infected, 1 = infected. COVID vaccination: 0 = not vaccinated, 1 = vaccinated with one dose, 2 = fully vaccinated with two doses. Chronic illness: 0 = no, 1 = yes. Unstandardized coefficients are reported. *SE* = standard error. CI = confidence interval.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Thus, we over-sampled with 343 participants in total to guard against insufficient power to test.

After omitting participants who failed both attention check questions ("please select the option to disagree", "please leave this question blank"), we arrived at a final sample of 305 participants who took part in the parallel design, of which 141 completed Study 2a and 164 completed Study 2b. 49.8 % of the participants were male, with a mean age of 40.85 years ($SD = 9.23$). On average, they had been employed for 9.46 years ($SD = 7.96$) and worked with the current supervisor for 4.55 years ($SD = 4.07$). Furthermore, they worked in various industries, including education/culture, healthcare, technology/telecommunication, finance, etc. Nearly half (48.5 %) had been diagnosed with COVID-19, 95.1 % of participants had received at least one vaccination dose.

5.1.2. Design & procedure

We conducted a vignette study with parallel designs for the experimental mediation approach in which participants were randomly assigned to either the measurement design or the manipulation design. Specifically, the measurement design in Study 2a had an (infectability: low or high) between-subjects factorial design, in which participants were randomly assigned to levels of infectability (workplace safety and engagement were measured) in one of two experimental conditions. The manipulation design in Study 2b had 2 (infectability: low or high) *3 (workplace safety: non-manipulated, low, or high) between-subjects factorial design, and participants were thus randomly assigned to a level of infectability and a level of workplace safety (and engagement was measured) in one of six experimental conditions. These conditions are comprised of high infectability/non-manipulated safety, high infectability/low safety, high infectability/high safety, low infectability/non-manipulated safety, low infectability/low safety, and low infectability/high safety. Overall, the complete procedure of this study is displayed in Fig. 4.

Participants were randomly assigned to one of the two designs and then randomly selected into one of the specific experimental conditions within each design. After reading the participant information and giving informed consent, participants read a scenario describing a personal health situation (see Appendix B: "*Please read the following vignette and imagine that you are exactly that person with that personal health condition in that particular work context…*"). Similar designs have been used and validated in research on the BIS models (Tybur et al., 2014).

We manipulated their individual differences in vulnerability to infections by priming them to be either very vulnerable or not vulnerable

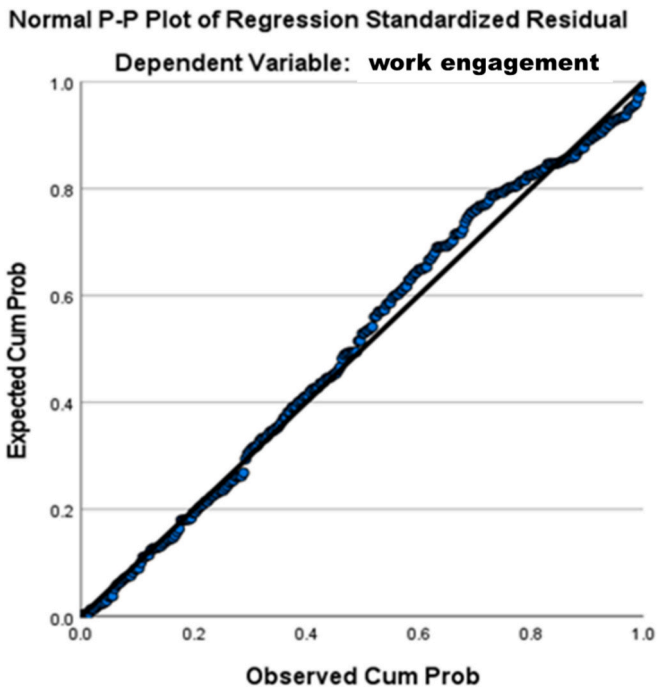

Fig. 3. The predicted probability (P—P) plot of the hypothesized relationship between perceived infectability and work engagement.

to infections based on items of the PVD scale (Duncan et al., 2009). In the high infectability condition, the vignette reads, "*Imagine being an employee with a very poor immune system. As a result, you are extremely vulnerable to any infectious diseases, and if an illness is going around at home or in the office, you will usually get it…*" In the low condition, the vignette reads, "*Imagine being an employee with a very good immune system. As a result, you are extremely not vulnerable at all to any infectious diseases, and if an illness is going around at home or in the office, you will usually not get it…*".

Participants were then instructed to complete the remaining experiment parts according to their assigned designs and concrete experimental conditions. In the manipulation design, participants were randomly assigned to a workplace safety condition. Hence, participants were randomly assigned to one of six experimental conditions in which they were at a certain level of infectability and a certain level of workplace safety. Adapting from the work safety scale (Hayes et al., 1998), we developed descriptive-paragraph materials on workplace safety at three levels. The vignette stated in the high workplace safety condition, "*Imagine that the working conditions in your job are generally sanitary and safe. Your office is a very hygienic workplace, everyone in your organization has their own room, and the cleaners help maintain the clean office every workday…*" In contrast, participants in the low safety condition read the highly contrasting wording with their unsanitary and unsafe workplace, compared to the high one ("*Imagine that the working conditions in your job are generally unsanitary and unsafe. Your office is a very unhygienic workplace, everyone in your organization shares a room, and the cleaners hardly ever help maintain the clean office…*"). However, we also involved the non-manipulated safety condition, which only provided neutral and irrelevant descriptions of their current workplace ("*The workplace in your office has an ergonomic desk and a matching chair…*").

Participants were not assigned to workplace safety conditions in the measurement design. Instead, after manipulating their infectability, we asked them in this design to respond to a short questionnaire asking how they would think about workplace safety. Finally, all participants were required to complete assessments of work engagement, manipulation checks, perceived infectability, controls (e.g., COVID-19 infection, vaccinations), and demographics in their assigned experimental conditions. They were debriefed and thanked upon their completion.

5.1.3. Materials and measures

We used the same measures for work engagement, perceived infectability, controls, and demographics as in Study 1. Moreover, we employed one choice question and one single-item measure for each predictor to assess the effectiveness of manipulations of infectability and workplace safety. In this sense, participants were first asked to indicate their personal health situation in the vignette and the extent to which they felt vulnerable to infectious diseases in the given scenario. Similarly, participants in the manipulation design were asked to report further specific work conditions in the vignette and then rate how they felt about that condition.

5.1.4. Analytic strategy

To examine the hypotheses, we used *t*-tests and the analysis of variance (ANOVA) to test the main effects and interaction effects of infectability in each design. We also used the PROCESS to test the mediation hypothesis in Study 2a. Besides, following the recommended strategies by Pirlott and MacKinnon (2016), we further tested the

Table 3
Results for hypotheses testing in Study 1.

	Model 5			Model 6			Model 7		
	Perceived workplace safety			Work engagement			Work engagement		
	(T2)			(T3)			(T3)		
Variable	*b*	*SE*	95 % CI	*b*	*SE*	95 % CI	*b*	*SE*	95 % CI
Intercept	4.91***	0.14	[4.624, 5.189]	4.25***	0.14	[3.979, 4.514]	4.31***	0.31	[3.704, 5.923]
Gender	0.13	0.17	[−0.199, 0.464]	0.01**	0.16	[−0.296, 0.315]	0.01	0.16	[−0.295, 0.317]
COVID infection	0.84	1.32	[−1.771, 3.442]	0.35	1.22	[−2.056, 2.76	0.34	1.23	[−2.075, 2.756]
COVID vaccination	−0.01	0.14	[−0.298, 0.273]	0.19	0.11	[−0.029, 0.418]	0.19	0.11	[−0.032, 0.417]
Chronic illness	−0.16	0.21	[−0.571, 0.258]	−0.04	0.20	[−0.431, 0.343]	−0.05	0.20	[−0.433, 0.342]
Perceived infectability(T1)	−0.13*	0.06	[−0.248, −0.002]	−0.13*	0.06	[−0.242, −0.015]	−0.13*	0.06	[−0.244, −0.016]
Perceived workplace safety(T2)							−0.01	0.06	[−0.124, 0.097]
HOL(T2)	0.41***	0.06	[0.292, 0.521]	0.32***	0.05	[0.210, 0.420]	0.32***	0.06	[0.206, 0.436]
Interaction	0.02	0.04	[−0.059, 0.102]	0.04	0.04	[−0.039, 0.110]	0.04	0.04	[−0.432, 0.342]
R^2	0.19***			0.16***			0.16***		

Note. $N = 279$. Unstandardized coefficients are reported Gender: 0 = male, 1 = female. COVID infection: 0 = not infected, 1 = infected. COVID vaccination: 0 = not vaccinated, 1 = vaccinated with one dose, 2 = fully vaccinated with two doses. Chronic illness: 0 = no, 1 = yes. HOL = health-oriented leadership. *SE* = standard error. CI = confidence interval.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

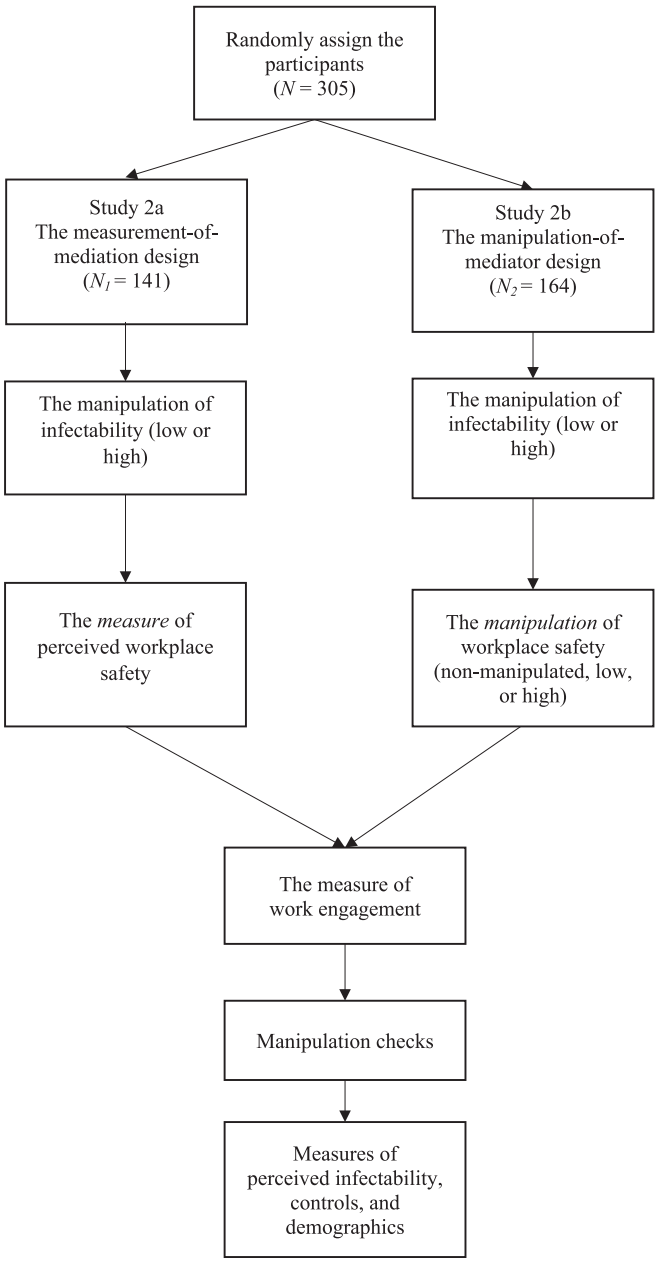

Fig. 4. The overall procedure in Study 2.

potential blockage and enhancement designs by comparing the simple means among the given experimental conditions via post-hoc Tukey tests.

5.2. Results

5.2.1. The measurement design (Study 2a)

Descriptive statistics and correlations are reported in Table 4. Participants in the high infectability condition rated their vulnerability as significantly more vulnerable (M = 5.76, SD = 2.28) than those in the low infectability condition (M = 2.03, SD = 1.26), $t(139) = -12.35$, $p < .001$. Similarly, those in the high infectability condition indicated their health situation (M = 1.02, SD = 0.13) to be significantly worse than those in the low infectability condition (M = 1.95, SD = 0.22), $t(139) = 29.70$, $p < .001$. Thus, results suggested that the manipulation of infectability was successful.

The results of the mediation analysis showed that participants in the low infectability condition rated their subsequent work engagement (M = 4.85, SD = 0.95) as considerably higher than those in the high infectability condition (M = 3.34, SD = 1.15, $t(139) = 8.55$, $p < .001$). Results showed that highly infectable employees reported lower work engagement than lowly infectable employees and support H1. Participants in the low infectability condition also rated their workplace (M = 4.92, SD = 1.00) as safer than those in the high infectability condition (M = 3.84, SD = 1.02), $t(139) = 6.34$, $p < .001$. Therefore, the main effect of their manipulated infectability on workplace safety was significant, and H2 was supported. When workplace safety was included in the model, the effect of infectability on work engagement remained significant, $b = -0.93$, $p < .001$. Finally, results of the indirect effect of manipulated infectability on work engagement via self-reported workplace safety showed a significant indirect effect, estimate = −0.58, 95 % CI [−0.82, −0.38], indicating that employees with high infectability felt less safe in their workplace and consequently showed less work engagement. Hence, H4 was supported.

5.2.2. The manipulation design (Study 2b)

Descriptive statistics and correlations per condition are reported in Tables 5 and 6 and illustrated in Fig. 5. Participants in the high infectability condition rated feeling significantly more vulnerable in the scenario (M = 6.03, SD = 1.90) than those in the low infectability condition (M = 2.04, SD = 1.34), $t(162) = -15.79$, $p < .001$, and they also indicated their health situation in the scenario (M = 1.00, SD = 0.00) to be significantly worse than those in the low infectability condition (M = 1.97, SD = 0.17), $t(162) = 45.33$, $p < .001$. Moreover, the ANOVA results showed that participants in the high safety condition rated their workplace (M = 6.40, SD = 0.71) as safer than those in the low safety condition (M = 1.74, SD = 0.98) and those in the non-manipulated condition (M = 5.29, SD = 1.67), $F(2, 161) = 226.50$, $p < .001$. Participants in the high safety condition (M = 1.98, SD = 0.14) reported their sanitary and safe workplace to be significantly different from those in the low safety condition (M = 1.02, SD = 0.14) and those in the non-manipulated condition (M = 2.16, SD = 0.71), $F(2, 161) = 112.36$, $p < .001$.

The ANOVA results showed that employees high in infectability rated their subsequent work engagement (M = 3.77, SD = 1.62) as lower than those low in infectability (M = 4.39, SD = 1.68), $F(1, 158) = 8.12$, $p < .005$, $\eta_p^2 = 0.05$, indicating that the main effect of manipulated

Table 4
Overall means, standard deviations, reliabilities, and correlations of the main variables in Study 2a.

	Variable	M	SD	1	2	3	4	5
1.	Perceived workplace safety	4.44	1.14	(0.72)*				
2.	Work engagement	4.18	1.28	0.65**	(0.95)			
3.	Personal health situation (Manipulation check)	1.53	0.50	0.50**	0.60**	–		
4.	Perceived infectability (Manipulation check)	3.70	2.58	−0.43**	−0.51**	−0.75**	–	
5.	Manipulation of infectability	1.45	0.50	−0.47**	−0.59**	−0.93**	0.72**	–

Note. N = 141. Personal health situation: 1 = I had a very poor immune system, 2 = I had a very good immune system. Perceived infectability: 1 = *not at all vulnerable* to 7 = *extremely vulnerable.* Manipulation of infectability: 1 = low condition, 2 = high condition. Cronbach's alpha values are in parentheses.
* $p < .05$.
** $p < .01$.

Table 5
overall means, standard deviations, reliabilities, and correlations of the numeric variables in Study 2b.

	Variable	*M*	*SD*	1	2	3	4	5	6	7
1.	Work engagement	4.14	1.67	(0.98)						
2.	Personal health situation (Manipulation check)	1.59	0.49	0.20**	–					
3.	Perceived infectability (Manipulation check)	3.62	2.51	−0.23**	−0.78**	–				
4.	Workplace condition (Manipulation check)	1.73	0.66	0.55**	0.12	−0.10	–			
5.	Perceived workplace safety (Manipulation check)	4.49	2.31	0.83**	0.22**	−0.26**	0.70**	–		
6.	Manipulation of infectability	1.40	0.49	−0.18*	−0.96**	0.78**	−0.10	−0.20*	–	
7.	Manipulation of workplace safety	2.00	0.82	0.63**	0.01	−0.04	0.71**	0.62**	0.01	–

Note. $N = 164$. Personal health situation: 1 = I had a very poor immune system, 2 = I had a very good immune system. Perceived infectability: 1 = *not at all vulnerable* to 7 = *extremely vulnerable*. Workplace condition: 1 = My working condition was unsanitary and unsafe, 2 = My working condition was sanitary and safe, 3 = I don't think my condition belongs to either of the above two types. Perceived workplace safety: 1 = *not at all safe* to 7 = *extremely safe*. Manipulation of infectability: 1 = low condition, 2 = high condition. Manipulation of workplace safety: 1 = low condition, 2 = high condition, 3 = non-manipulated condition. Cronbach's alpha values are in parentheses.
* $p < .05$.
** $p < .01$.

Table 6
Means and standard deviations of the main variables by experimental condition in Study 2b.

Manipulation of IV: Infectability	Manipulation of the mediator: workplace safety											
	Low workplace safety			High workplace safety			Non-manipulated			Total		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	***N***
High infectability	2.04_a	1.01	23	5.09_b	0.73	18	4.44_c	0.21	24	3.77	1.62	65
Low infectability	2.49_a	1.06	31	5.28_b	0.90	37	5.22_b	0.23	31	4.39	1.68	99
Total	2.30	1.05	54	5.22	0.85	55	4.88	0.13	55	4.14	1.68	164

Note. $N = 164$. Between experimental groups, values with different subscripts within a row differ significantly with $p < .01$.

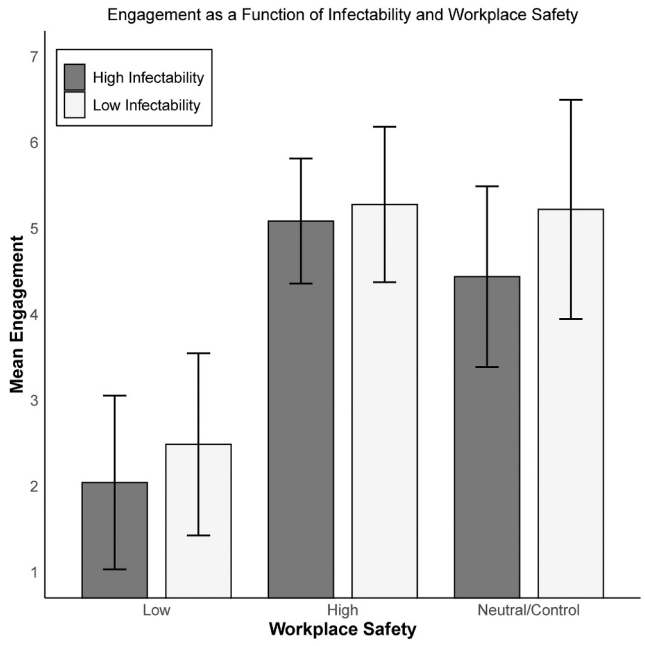

Fig. 5. Mean scores of work engagement for experimental groups in Study 2b.

infectability on work engagement was significant. Hence, H1 was supported. Moreover, participants in the low safety condition rated their subsequent engagement ($M = 2.30$, $SD = 1.05$) as less than those in the high safety condition ($M = 5.22$, $SD = 0.85$) and those in the non-manipulated condition ($M = 4.88$, $SD = 1.24$), $F(2, 158) = 123.18$, $p < .001$, $\eta_p^2 = 0.61$. Hence, the main effect of the manipulated workplace safety on work engagement was significant, indicating that H3 was supported. However, the interaction between manipulated infectability and workplace safety on work engagement was non-significant, $F(2, 158) = 1.05$, $p = .35$, $\eta_p^2 = 0.01$. Overall, the ANOVA results revealed that the six different experimental conditions showed significant between-group differences in work engagement, $F(5, 158) = 53.96$, $p < .001$, $\eta_p^2 = 0.63$, indicating support for the theorized mediation we proposed.

Post-hoc Tukey multiple comparisons of means showed that, among participants high in infectability, there were significant pairwise differences depending on workplace safety manipulations: Those in the low safety condition showed less subsequent engagement relative to those in the non-manipulated condition and the high safety condition ($p < .001$). Those in the high safety condition further showed higher engagement than those in the non-manipulated condition ($p = .047$). An ANOVA comparing three workplace safety conditions only within the high infectability condition was also significant, $F(2, 158) = 51.71$, $p < .001$, $\eta_p^2 = 0.40$. Thus, results indicate that under the condition of high infectability, work engagement varies as a function of workplace safety.

Within the low infectability condition, participants in the low workplace safety condition indicated lower engagement compared to the high safety and the non-manipulated conditions ($p < .001$). The engagement values did not differ between the low infectability manipulation's high and non-manipulated safety conditions ($p = .82$). An ANOVA comparing three workplace safety conditions only within the high perceived infectability condition was also significant, $F(2, 158) = 76.23$, $p < .00$, $\eta_p^2 = 0.49$, indicating that work engagement varies as a function of workplace safety. However, results imply that low workplace safety decreases participants' engagement compared to the "neutral" (non-manipulated) condition, whereas high workplace safety condition fails to enhance their engagement.

Tukey comparisons of means showed no significant differences between participants of different infectability manipulations within workplace safety manipulations. In line with suggestions by Pirlott and MacKinnon (2016), we looked at the post-hoc comparison of the experimental conditions in which the levels of infectability corresponded with the levels of workplace safety in light of the conceptual model and found a significant difference in engagement, with the highest mean difference of all pairwise comparisons, ΔM (High

infectability/Low Safety and Low Infectability/High Safety) = 3.24, 95 % CI [2.44, 4.03], $p < .001$. The above results support H4 by providing evidence of the causal effect of workplace safety on work engagement. Overall, Study 2 indicated that a higher perceived infectability risk lowers employees' work engagement because these high-risk employees are more concerned about workplace safety.

6. Discussion

We undertook this research to examine if employees with underlying vulnerabilities to infectious disease reacted differently to health threats at work. Considering the pandemic in parts of the world and the potential danger of future disease threats affecting the post-pandemic workplace, it is important to consider the role of individual differences in perceived infectability. Results from two studies with different research designs largely supported our hypotheses. Consistent with the BIS and JD-R models, individual differences in perceived infectability among employees affected their work engagement during infectious disease threats. Employees who thought themselves at risk of infection showed greater concerns about the physical safety of their work environment, resulting in lower work engagement. We found this effect both in a time-lagged field survey administered to workers and in two vignette experiments with simulated workplace scenarios. However, our findings did not support the hypothesized buffering effect of HOL for employees who perceived higher risks of infection. These findings were obtained in studies with different designs and field settings, adding confidence to the generalizability of the BIS/JD-R model predictions in our research into various samples across occupations and workplaces.

6.1. Theoretical implications

This research first contributes to the behavioral immune system literature by broadening its scope to the workplace. Research on BIS has primarily focused on the effects of individual differences in disease vulnerability on more fundamental social judgment processes, such as the fear and avoidance of strangers or preferences for healthy-looking romantic partners (e.g., Ackerman et al., 2018; Murray et al., 2023). To our knowledge, this is the first study connecting the BIS mechanism with individual work experiences, particularly within an organizational context during an acute health threat, the pandemic (cf. Schaller et al., 2022). Moreover, because infectious disease outbreaks like the flu or the coronavirus (that surged again recently in the summer of 2024) are expected to increase in prevalence in the modern, globalized workplace (Kniffin et al., 2021; Van Bavel et al., 2020), paying attention to individual differences in infectability among employees will be an important aspect of workplace health and safety regulations, especially with a view to caring for the needs of the more vulnerable employees.

Second, this research contributes to studies on work engagement. Various studies have examined how psychological traits and lower-order individual differences shape employees' work engagement, for example, examining the impact of conscientiousness, self-efficacy, and positive mood (e.g., Christian et al.7090, 2011; Mäkikangas et al., 2013; Young et al., 2018). Our research indicates that beyond these identified differences, stable individual differences in health concerns—employees who consider themselves chronically susceptible to infection—may impact their work engagement, and result in the more vulnerable employees wanting to work more often from home to avoid getting sick.

Third, this research contributes to the job demands-resources theory by establishing employees' infection risk as a significant job demand, especially when there is a disease outbreak in the workplace (Nahrgang et al., 2011; Tuckey et al., 2015). Tighter workplace safety policies (e.g., wearing masks, individual offices) can be seen as an additional job resource that mitigates against these health-related threats. Our investigation of the impact of perceived infectability also addresses the call from researchers to expand threat demands beyond the more traditionally studied threats of job insecurity and harassment to include health-related threats (cf. Searle & Tuckey, 2017). Taken together, our findings both confirm and expand knowledge of the JD-R model (Bakker & Demerouti, 2024).

Fourth, our research contributes to workplace safety research by revealing the importance of individual differences in whether employees view physical aspects of the workplace as a potential stressor (Beus et al., 2016; Burke & Signal, 2010). Our investigation shows that disease-avoidance mechanisms play a critical role in how safe employees feel in their workplace. This finding advances the understanding of the established integrated safety model by focusing on specific contexts of individual health concerns (cf. Beus et al., 2016). Our findings obtained with a diverse workforce sample also broaden workplace safety research by showing the importance of health and safety standards to all industrial sectors and occupations, including regular office work (Chang et al., 2021).

Fifth and last, our research contributes to leadership research by showing that employees perceive health-oriented leadership (HOL) as a precondition for their work engagement and their perceptions of workplace safety. Our research did not support the prediction that a HOL style from management buffers the negative effects of a high perceived infection risk among workers. However, this null finding contradicts earlier findings on the role of HOL, especially during the pandemic (e.g., Günther et al., 2022; Klebe et al., 2021). Yet, it is aligned with recent findings that the role of HOL is weaker in workplaces in which employees work mostly remotely (e.g., Klebe & Felfe, 2023). We consider our findings can be explained in several ways: First, the emphasis in HOL is not per se on interventions of infection threats (e.g., social distancing, handwashing, wearing masks), but considers all aspects of a safe and healthy workplace, including managing work stress. Thus, it is possible that the HOL measure applied here was not tailored enough to the realities of leading during a pandemic threat. Second, participants may have been biased because their perceptions and observations of their supervisors' health-oriented activities may have been constrained by having infrequent and insufficient interactions with them during the pandemic, as many workplaces were operating remotely. Third, it is worth mentioning that concerns have been raised recently about the validity of the HOL questionnaire, with some concrete suggestions for improving the measure (e.g., Rudolph et al., 2020).

6.2. Practical implications

Our study offers several practical implications. First, organizations should recognize the importance of individual differences in disease vulnerability. This may help them better understand what the more susceptible groups are and monitor why certain employees may fare worse during infection outbreaks, such as the seasonal flu. Employers may thus make special work arrangements customized to these employees to protect them from getting infected, such as allowing them to work more frequently from home in case of disease outbreaks and stay online during work hours.

Second, organizations should consider developing public hygienic strategies that are selectively tailored to special groups with high disease vulnerability. More importantly, beyond these highly infectable employees, organizations would always do well in creating healthy, sustainable, and inclusive workplaces for all employees through safe and hygienic measures. This may help employees reduce the likelihood of being at risk of infections and sickness when regularly interacting with colleagues or customers. Notably, for those working in environments where infection threats are high, such as in hospitals, elderly care homes, schools, and restaurants, organizations should be sufficiently attentive to the physical safety and psychological health of their front-line employees.

Third, given the potential importance of HOL perceptions for employee work engagement, managers should consider using more HOL-related practices. Setting or following hygiene protocols and paying attention to their individual employees' health concerns can help

cultivate a safe and healthy work environment and lead employees to be more invested in their work if they realize their supervisor prioritizes their health and safety.

6.3. Limitations and future directions

First, due to the self-reported nature of our data in Study 1, we cannot eliminate the problem of common method bias, despite the time-lagged design giving us some confidence in the causal directionality of our claims. However, future research would benefit from using multiple source data (e.g., supervisor-subordinate dyads), for instance, to get independent ratings on workplace safety and employee engagement from supervisors and co-workers.

Second, the vignette-based design in Study 2 is limited to compromised external validity (Aguinis & Bradley, 2014), and the results of such a design were not completely convergent with Study 1's results. In particular, the manipulation-of-mediator design failed to show evidence for complete mediation of the relationship between infectability and work engagement through perceptions of workplace unsafety. While the current findings of the parallel design support our assumptions, we recommend that future research try to replicate our findings using a field- or quasi-experimental design with greater internal and external validity in understanding the BIS model.

Third, although our sample was large and reasonably diverse regarding the industries and occupations participants worked in, our findings were conducted with samples of workers from the United Kingdom–a highly individualistic and loose culture–with a relatively high tolerance for social deviance and rule-breaking behaviors. Our findings may not generalize to more collectivistic, tighter cultures such as China and Japan. Indeed, there is evidence that tighter cultures fared better during the COVID-19 pandemic than looser cultures, and it may well be that workplaces in tighter nations are generally safer and better prepared for infectious disease outbreaks (Gelfand et al., 2021). Therefore, we encourage future research to replicate our findings with employees in nations with different cultural characteristics.

Finally, our research exclusively focused on work engagement as the outcome of disease avoidance motivations. Future research could consider how other work-related outcomes, such as turnover intention and organizational commitment, are affected by employee infectability risk. It would be a significant extension of our research to evaluate how employees high in infectability fare in the post-pandemic workplace as infection risks go down and the vaccination programs are doing their work. Meanwhile, it would be interesting to investigate the work experiences of those employees low in infectability when they have family members at high risk of vulnerability. Finally, further studies could also examine the link between employees' subjectively perceived infection risk and the objective quality of their physiological immune system to see if they overlap.

7. Conclusion

Overall, the present research found that individual differences in vulnerability to infectious diseases predicted the perception of workplace safety and work engagement in samples of data from employees collected during the COVID-19 pandemic. We found that employees with higher infection risks were more concerned about workplace safety, resulting in lower work engagement. These findings are aligned with the BIS and JD-R models and suggest that, to meet the needs of employees at risk of infection, it is important to create physically safe workplaces in which the risk of an infection outbreak is kept to a minimum.

Ethical statement

Both studies included in this research were approved by the Institutional Review Board at the school, with which the first author was affiliated (Study 1: VCWE-2021124, Study 2: VCWE-2022056). Informed consent was obtained from all participants prior to participation.

CRediT authorship contribution statement

Jian Shi: Writing – review & editing, Writing – original draft, Visualization, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Alexandra (Sasha) Cook:** Writing – review & editing, Validation, Methodology, Formal analysis, Conceptualization, Visualization. **Mark van Vugt:** Writing – review & editing, Supervision, Investigation, Conceptualization. **Arnold B. Bakker:** Writing – review & editing, Conceptualization.

Declaration of competing interest

We have no conflicts of interest to disclose.

Data availability

Data will be made available on request.

Appendix A

Measures used in Studies 1&2

Perceived infectability (Perceived vulnerability to disease, PVD; Duncan et al., 2009; measured at Time 1 in Study 1)

1. In general, I am very susceptible to colds, flu and other infectious diseases.
2. I am unlikely to catch a cold, flu or other illness, even if it is ‘going around’. (Reverse-scored)
3. If an illness is ‘going around’, I will get it.
4. My immune system protects me from most illnesses that other people get. (Reverse-scored)
5. I am more likely than the people around me to catch an infectious disease.
6. My past experiences make me believe I am not likely to get sick even when my friends are sick. (Reverse-scored)
7. I have a history of susceptibility to infectious diseases.

Perceived workplace safety (Cox & Cheyne, 2000; measured at Time 2 in Study 1 & Study 2a)

1. Our operational targets would often conflict with health and safety measures. (Reverse-scored)
2. I am not given enough time to get the job done safely sometimes. (Reverse-scored)
3. My work conditions would sometimes hinder my ability to work safely. (Reverse-scored)
4. There are always enough people available to get the job done safely in that situation.

5. Unsafe conditions are promptly corrected at my work.

Health-oriented Leadership (HOL, Franke et al., 2014; measured at Time 2 in Study 1)

1. My supervisor realizes in time that I need to take a break.
2. My supervisor notices when I reach my limits.
3. My health is very important to my supervisor.
4. It is important to my supervisor to reduce health-related stress and strain and reduce risks at my workplace.
5. My supervisor makes sure that I have enough time to relax and recover.
6. My supervisor makes sure that the topic of health receives sufficient attention at the workplace.
7. My supervisor reduces my work stress through improvements regarding work organization (e.g., setting priorities, prevention of disruptions, daily planning).
8. My supervisor reduces my work stress through improvements regarding worktime (e.g., ensuring sufficient breaks, avoidance of overtime, taking vacation days).

Work Engagement (UWES: Schaufeli et al., 2006; measured at Time 3 in Study 1 & both designs in Study 2)

1. In that situation, I would feel bursting with energy at my work.
2. In that situation, I would feel strong and vigorous at my job.
3. In that situation, I would feel like going to work when I get up in the morning.
4. In that situation, I would be more enthusiastic about my job.
5. In that situation, my job would inspire me.
6. In that situation, I would be proud of my work.
7. In that situation, I would immerse myself in my work.
8. In that situation, I would feel happy when working intensely.
9. In that situation, I would get carried away when working.

COVID-19 Symptoms (Measured in both studies)

1. Did you get diagnosed with the COVID-19 virus?
   0 = No, I have not experienced any symptoms of COVID-19;
   1 = Yes, I got officially diagnosed;
   If yes: what severity of confirmed symptoms did you have?
   (1 = *Not severe at all* to 7 = *Extremely severe*)

COVID-19 Vaccination (Measured in both studies)

1. Did you receive the COVID-19 vaccinations?
   0 = No;
   1 = Yes, I got a vaccination with one dose;
   2 = Yes, I got fully vaccinated with two doses;
   3 = Yes, I got fully vaccinated with the booster dose

Chronic Illness (Measured in both studies)

1. Do you have a chronic illness or chronic medical condition?
   0 = No;
   1 = Yes.

Perceived risk of COVID-19 (Jaspal et al., 2022; Measured in both studies)
To what extent do you agree with the following statements about your current health situation? (1 = *Strongly disagree* to 7 = *Strongly agree*)

1. I have a gut feeling that I am likely to get infected with the COVID-19.
2. I feel vulnerable to the COVID-19 infection.
3. I find I picture myself getting the COVID-19.
4. I feel stressed regarding the COVID-19 situation.
5. I think the COVID-19 is much more of a problem compares to the seasonal flu.
6. I think the COVID-19 situations in which I'm living are severe.

Health situation (measured at Time 1 in Study 1)
How would you say your health is in general?
1 = terrible; 2 = poor; 3 = fair; 4 = good; 5 = excellent.

Appendix B

Materials for Study 2

Manipulation Materials of Infectability (Used in both designs of Study 2)

High Infectability Condition

Imagine being an employee with a very poor immune system. As a result, you are extremely vulnerable to any infectious diseases (e.g., colds, flu, Coronavirus), and if an illness is going around at home or in the office, you will usually get it. Moreover, you are more likely to get sick than others around you in your family and at your work, so you are infected much earlier than others and recover very slowly. In fact, your medical history explicitly proves these experiences in your health situation.

Low Infectability Condition

Imagine being an employee with a very good immune system. As a result, you are extremely not vulnerable at all to any infectious diseases (e.g., colds, flu, Coronavirus), and if an illness is going around at home or in the office, you will usually not get it. Moreover, you are less likely to get sick than others around you in your family and at your work, so you are infected much later than others and recover very quickly. In fact, your medical history explicitly proves these experiences in your health situation.

Please think a few minutes about how you feel about that personal health situation just described. Write down at least one sentence to describe separately how you would feel and how you typically act in that situation.

Manipulation Materials of Workplace Safety (Used in Study 2b)

High Workplace Safety Condition

Imagine that the working conditions in your job are generally sanitary and safe. Your office is a very hygienic workplace; everyone in your organization has their own room, and the cleaners help maintain the clean office every workday. As a result, if a disease is going around, then not many office workers in your organization will get it. You and your colleagues are required to follow the safety and health regulations in your organization very closely. In the past, your organization has always been concerned about a safe and sanitary workplace. For example, they always provided enough safety and hygiene equipment as well as useful safety training programs. Importantly, your supervisor always discusses safety issues with your team or involves the team in maintaining safety and hygiene standards. He/she always praises and thus is willing to reward our safe and hygienic behaviors.

Low Workplace Safety Condition

Imagine that the working conditions in your job are generally unsanitary and unsafe. Your office is a very unhygienic workplace; everyone in your organization shares a room, and the cleaners hardly ever help maintain the clean office. As a result, if a disease is going around, then many office workers in your organization will get it. You and your colleagues are not required to follow the safety and health regulations in your organization very closely. In the past, your organization has never been concerned about a safe and sanitary workplace. For example, they never provided enough safety and hygiene equipment as well as useful safety training programs. Importantly, your supervisor never discusses safety issues with your team or involves the team in maintaining safety and hygiene standards. He/she never praises and thus is not willing to reward our safe and hygienic behaviors at all.

Non-manipulated Condition

Imagine that the work conditions in your job are basically like below: you have an office room in your organization. The workplace in your office has an ergonomic desk and a matching chair. A desktop computer with a monitor standard is fixed on your desk. In front of the monitor, a mouse, a keyboard and a fax phone are on your desk. The stable internet connection and telephone systems offer you effective communication and collaboration support. Besides, the basic office stationery items, such as pens, paper, notebooks, and post-its, are available for you to work. There is a light on the ceiling in your room. Moreover, you share the multifunction printer and the kitchen with a coffee machine in the common area with others.

Manipulation Checks of Infectability (Used in both designs of Study 2)

1. Which type of personal health situations did you have in the vignette?
   1 = I had a very poor immune system;
   2 = I had a very good immune system.
2. In the given health situation of the vignette, to what extent did you feel vulnerable to infectious diseases (e.g., colds, flu, Coronavirus)?
   (1 = *not at all vulnerable* to 7 = *extremely vulnerable*)

Manipulation Checks of Workplace Safety (Used in Study 2b)

1. Which type of working conditions did you have in the vignette?
   1 = My working condition was unsanitary and unsafe;
   2 = My working condition was sanitary and safe;
   3 = I don't think my condition belongs to either of the above two types.
2. In the given working condition of the vignette, how safe or unsafe did you feel about your workplace?
   (1 = *not at all safe* to 7 = *extremely safe*)

Appendix C

Table 1
Confirmatory factor analysis results in Study 1

Model		$\chi 2$	*df*	$\Delta\chi 2$	RMSEA	CFI	TFI	SRMR
Model 1	Four-factor model (Perceived infectability, HOL, workplace safety, and work engagement)	112.66	71		0.05	0.98	0.98	0.04
Model 2	Three-factor model (Workplace safety and HOL loaded onto one factor)	645.14	74	532.48	0.17	0.79	0.74	0.11
Model 3	Three-factor model (Workplace safety and work engagement loaded onto one factor)	673.08	74	560.42	0.17	0.77	0.72	0.14

Note. HOL = health-oriented leadership; CFI = comparative fit index; TLI = Tucker–Lewis's index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual. Perceived infectability, workplace safety, and HOL were generated into three parcels for each variable using the item-to-construct balance method, and work engagement was generated with three parcels in terms of its dimensional scores.

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