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Learning Demands, Work-Related Resources, and Job Stressors and their Relationships to Creative Performance and Health

Jürgen Glaser[1], Christian Seubert[1], Severin Hornung[1], and Britta Herbig[2]

[1] Institute of Psychology, Leopold-Franzens-University Innsbruck, Austria

[2] Institute for Occupational, Social and Environmental Medicine, Ludwig Maximilian University Munich, Germany

Correspondence should be addressed to:

Prof. Dr. Jürgen Glaser
Institute of Psychology
University Innsbruck
Innrain 52, A-6020 Innsbruck, Austria
Phone: +43-512-507-37460
E-mail: juergen.glaser@uibk.ac.at

Abstract

We propose an integrated model of learning demands, work-related resources, and job stressors, which incorporates core assumptions of work design in predicting processes of learning and performance as well as health impairment. The model was tested in a heterogeneous sample of 830 employees using structural equation modeling. Empirical results largely support theoretical assumptions. Learning demands and work-related resources were positively related to intrinsic motivation and creative performance. Job stressors and low work-related resources were predictive for health impairment. The suggested tripartite taxonomy reconciles inconsistent research findings on the impact of work characteristics. The model provides practical guidance for work analysis and design by clarifying relationships between established work characteristics, job performance, and worker health.

Keywords: learning demands, resources, stressors, motivation, creative performance, health

Conditions of contemporary work have been substantially transformed by trends towards globalization, new information and communication technologies, service and knowledge work, increased flexibility, and individualization (European Agency for Safety and Health at Work, 2000). Compared to "old-fashioned" work systems with open-ended full-time contracts, routinized work processes, and stable social relationships, new forms of employment (e.g., self-employment, temporary contracts), work organization (e.g., telework, project teams), and challenges (e.g., ageing workforces, work intensification) characterize modern working life. Today, employees are charged with self-directed adaptation and learning to maintain and improve their employability (Nijhof, 2005). Dynamic work tasks require more creative problem-solving (Shalley, Gilson, & Blum, 2009). Intensification and dissipating boundaries of work increasingly affect other life domains (Byron, 2005). Negative consequences comprise chronic strain, health impairment, and absenteeism (Eurofound, 2010). New demands of work not only affect the prevalence of stressors, such as work overload and job insecurity, but also challenge the role of other work characteristics, such as regulation demands, skill-discretion, task control, and social support. Rather than creating new labels for psychosocial aspects of modern work, respective changes can mostly be understood as reconfigurations in work characteristics. Therefore, it is important to rethink "traditional" categories of work characteristics, differentiate them more precisely, and analyze their prevalence and changing profiles in modern workplaces.

The present study makes a theoretical and an empirical contribution. First, we review different models of work characteristics and propose an integrative taxonomy to predict processes of learning and performance as well as health impairment. Second, we test our assumptions in a structural equation model of survey data from different work settings. Finally, we discuss theoretical and practical implications for the design of healthy work.

Learning demands, work-related resources, and job stressors

Two important criteria for humane work are personality development and absence of health impairment. Personality development includes requirements to acquire new skills and knowledge as well as maintenance learning to prevent unlearning and dequalification (Hacker, 2003). This criterion relates to the basic human need for competence (Deci & Ryan, 1985) and life-long-learning requirements in modern work systems. Absence of health impairment focuses on physical and psychosocial well-being, such as prevention of strain and work-related illness through occupational safety and health programs to maintain work-ability among (ageing) workforces.

Action regulation theory (ART; Hacker, 2003) distinguishes between work characteristics that are beneficial for learning and personality development (learning demands) and conditions that are detrimental for action regulation and health (job stressors). The former are psychological regulation requirements, such as challenging or complex tasks, whereas the latter refer to regulation impediments, such as discrepancies between task goals, tasks, and learning conditions, or tasks and performance conditions (Büssing & Glaser, 2000; Greiner, Ragland, Krause, Syme, & Fisher, 1997). A third category, work-related resources, has mainly supportive functions in the psychological regulation of work demands. Learning demands stimulate goal-oriented activity, learning, and personality development, whereas work-related resources as such do not (Frese & Zapf, 1994). The resulting tripartite taxonomy of requirements, obstacles, and resources for action regulation is condition-related and offers a practical tool for work design to improve positive characteristics of work (learning demands and work-related resources) and to reduce negative ones (job stressors). The framework of ART can inform work design research, which tends to confound these three categories of work characteristics.

Work design scholars have long aimed to distinguish work characteristics that facilitate intrinsic motivation, engagement, creativity, and other aspects of learning and performance from conditions that impair well-being and health. As early as 1979, Karasek criticized the "tendency to describe all structurally determined work characteristics as 'job demands' regardless of their drastically different effects on psychological functioning", arguing that a more fine-grained distinction is needed to account for the "inconsistent finding that 'time pressure demands' are associated with strain symptoms, while 'intellectual demands' are not" (p. 286).

In the demand-control-model (DCM), Karasek (1979) postulated that psychological strain results from the interactive effect of job demands and decision latitudes (discretion). In this research tradition, job demands are operationalized as work overload, whereas job control (autonomy or decision latitudes) is sometimes aggregated with skill discretion. According to the DCM, job strain results from high job demands combined with low job control. Active jobs (i.e., high demands, high control) enable the development of new behavioral patterns, whereas passive jobs (i.e., low demands, low control) induce a decline in overall activity. The demand-control-support model (DCSM; Karasek & Theorell, 1990) includes social support (by co-workers and supervisors) as an additional work-related resource. Although beneficial direct and/or moderating effects of job control and social support have been found in numerous studies, evidence for the DC(S)M as a whole is mixed (de Lange, Taris, Kompier, Houtman, & Bongers, 2003).

The job demands-resources model (JDR; Bakker & Demerouti, 2007) extends the DC(S)M by including broader categories of job demands and resources. Job demands are defined as work characteristics that trigger effort-driven processes, consume physical and psychological energy, and increase the risk of burnout and health impairment. This conceptualization focuses on the loss and depletion of energy (e.g., due to work overload),

but neglects positive effects of learning demands for skill acquisition and performance. In the JDR, job resources like autonomy, feedback, and social support are assumed to evoke motivation, engagement, and performance. Certain types of job resources (e.g., social support, decision latitudes) might indeed be useful to cope with certain demands (e.g., work overload). However, in the absence of learning demands, they might not be beneficial for processes of learning and skill acquisition.

Focusing on positive aspects of work, the job characteristics model (JCM) by Hackman and Oldham (1976) posits that certain core dimensions of work predict intrinsic motivation: skill variety, task identity, task significance, autonomy, and feedback. Hackman and Oldham (1976) hypothesized that growth needs increase in complex jobs that stimulate learning. "Individuals who work on complex, challenging jobs might discover that they need new knowledge or skills to accomplish the work – and gradually acquire what they need in the course of doing the work" (Kulik, Oldham, & Hackman, 1987, p. 287). Acquired knowledge and skills are transferred to other tasks and life domains, thus contributing to personality development (Hacker, 2003; Kulik et al., 1987).

In a meta-analysis, Crawford, LePine, and Rich (2010) argued that certain work characteristics have ambiguous effects on motivation and health. Drawing upon previous work (Cavanaugh, Boswell, Roehling, & Boudreau, 2000), the authors distinguish between challenge and hindrance demands (stressors). Challenge demands facilitate learning and growth, whereas hindrance demands threaten regulation capacities and health. The challenge-hindrance distinction is rooted in transactional stress theory (Lazarus & Folkman, 1984) and thus depends on the subjective (primary and secondary) appraisal by the working individuals.

To summarize our review, beneficial aspects of learning demands are an underresearched topic in the work design literature. Positive work demands are typically confounded with job control (DCM) or resources (JDR). The distinction between challenge

and hindrance demands based on transactional stress concepts is of limited usefulness for purposes of work design, which traditionally focuses on objective working conditions, rather than subjective appraisal (Hacker, 2003).

In the following, we introduce and test a model to integrate empirical evidence on the impact of work characteristics on learning and performance as well as health impairment. Based on the reviewed literature, we distinguish between: a) beneficial learning demands, such as task variety, complexity, and completeness (Campbell, 1988; Hacker, 2003; Hackman & Oldham, 1976); b) work-related resources in terms of autonomy and social support (Hacker, 2003; Karasek & Theorell, 1990); and c) stressors as adverse conditions, such as overload, obstacles, and conflicts (Frese & Zapf, 1994; Greiner et al., 1997). The proposed model, depicted in Figure 1, predicts a beneficial ("positive") process of personality development and a detrimental ("negative") process of health impairment, both of which are defined by short-term and long-term indicators of positive and negative health (WHO, 1986). Short-term outcomes are assumed to mediate the effects of psychosocial work characteristics on longer-term consequences.

[insert Figure 1 about here]

Hypotheses

Consistent with reviewed taxonomies of psychosocial work characteristics and meta-analytic results (Crawford et al., 2010), the first hypothesis establishes the taxonomy of learning demands, work-related resources, and stressors, based on the distinction between requirements, resources, and problems for action regulation.

H1: Learning demands, work-related resources, and stressors are empirically distinct categories of psychosocial work characteristics.

Learning requirements are critical for personality development at work. Consistent with the notion of active jobs in the DCM, longitudinal results suggest that work

characteristics can foster learning-related behavior in the longer-term (de Lange, Taris, Jansen, Kompier, Houtman, & Bongers, 2010). In this study, we used intrinsic motivation as a short-term response and creative performance as a longer-term consequence. Intrinsic work motivation is a classic outcome of positive work characteristics, such as job autonomy, skill variety, and challenging tasks (Amabile, Conti, Coon, Lazenby, & Herron, 1996; de Witte, Verhofstadt, & Omey, 2007; Fried & Ferris, 1987). Creative performance is of particular interest in contemporary organizations. Creative requirements and problem-solving demands have been shown to predict creativity at work (Unsworth, Wall, & Carter, 2005; Zhou, Hirst, & Shipton, 2012). However, intrinsic work motivation has been suggested, together with creative skills and expertise, as a more proximal determinant (Amabile, 1997). Integrating these assumptions, our second hypothesis assumes a mediating role of intrinsic motivation between work characteristics and creativity.

H2: Learning demands are positively related to intrinsic motivation and creative performance, such that intrinsic motivation mediates between learning demands and creative performance.

In addition to learning demands, work-related resources are associated with motivation and job performance (Bakker & Demerouti, 2007; Gagné & Deci, 2005). Meta-analytic results show that autonomy is positively related to job satisfaction, motivation, commitment, and performance, and negatively related to physical symptoms, emotional distress, absenteeism, and turnover (Spector, 1986). Autonomy can increase intrinsic motivation, stimulate workers to invest more effort, persist in difficult tasks, and develop new solutions (Amabile et al., 1996). However, work-related resources should not be narrowed down to autonomy, but can also arise from the social context of work (Viswesvaran, Sanchez, & Fisher, 1999). For instance, in a recent meta-analysis, team process variables of support

displayed the closest relationships with creativity at work (Hülsheger, Anderson, & Salgado, 2009). Our third hypothesis reflects this beneficial role of work-related resources.

H3: Work-related resources are positively related to intrinsic motivation and creative performance, such that intrinsic motivation mediates between work-related resources and creative performance.

Psychosocial job stressors are associated with various indicators of health impairment. In this study, we used psychological irritation as a short-term strain symptom and musculoskeletal pain as a longer-term outcome. Irritation is an indicator for lack of cognitive and emotional recovery from exposure to work stressors, such as overload (Höge, 2009; Mohr, Müller, Rigotti, Aycan, & Tschan, 2006). Musculoskeletal problems have also been linked to stressors like workload, organizational constraints, and interpersonal conflict, high work pace, and physical factors (Houtman, Bongers, Smulders, & Kompier, 1994; Nixon, Mazzola, Bauer, Krueger, & Spector, 2011). However, longitudinal effects are weak, suggesting that musculoskeletal problems are a more distal outcome (Lang, Ochsmann, Kraus, & Lang, 2012). Geurts and Sonnentag (2006) argued that states of impaired recovery mediate between job stressors and more chronic health problems. Indeed, a recent longitudinal study identified need for recovery from work as the strongest predictor for muscoskeletal distress (Devereux, Rydstedt, & Cropley, 2011). Our fourth hypothesis reflects this process perspective on job strain as progressing from short-term states of impaired recovery to more chronic and somatic symptoms.

H4: Job stressors are positively related to irritation and musculoskeletal pain, such that irritation mediates between job stressors and musculoskeletal pain.

The important role of work-related resources in preventing health impairment has been corroborated by a large number of studies. Decreases in job control are associated with increases in job strain and indicators of ill-health, such as heart and vascular diseases (Belkic,

Landsbergis, Schnall, & Baker, 2004). Concurrently, high levels of autonomy are associated with lower strain symptoms (Spector, 1986). Other work-related resources have similar effects. Meta-analytic results suggest that social support decreases strain and health impairment (Viswesvaran et al., 1999). Our fifth hypothesis assumes that resources play a role in reducing the progression from short- to long-term job strain (Geurts & Sonnentag, 2006).

H5: Work-related resources are negatively related to irritation and musculoskeletal pain, such that irritation mediates between work-related resources and musculoskeletal pain.

Method

Sample

The study was part of a larger project on creativity and health at work, funded by the German Federal Institute for Occupational Safety and Health (Herbig & Glaser, 2013). Cross-sectional survey data were gathered through an online questionnaire, access to which was restricted to cooperating companies and employees. Overall, 830 employees participated in the study: 377 from seven small and medium-sized companies (health care services, knowledge intensive services, metal and wood industry) and 433 from the general working population. The sample included 471 men and 289 women (70 missing values). Mean age was 39.67 years (SD = 11.76; range 17 to 72 years). Organizational tenure ranged from newly hired (0) to 49 years (M = 129.9 months, SD = 117.6). 26.3% of the participants held supervisor positions. Mean number of subordinates was 23 (SD = 62.7, range 1 to 500). 52.9% worked full-time (≥ 35h/week) and 5.6% worked less than half-time (≤ 18h/week). Overall, the sample covers a broad cross-section of the working population in Germany.

Measures

The administered questionnaire assessed psychosocial work characteristics (learning demands, work-related resources, job stressors) and strain-related outcomes (short-term: motivation, irritation; longer-term: creative performance, musculoskeletal pain). Each construct was measured with three items, selected from validated scales based on content validity and psychometric properties. Descriptive statistics are displayed in Table 1.

Work characteristics scales were drawn from the German self-report instrument "Activity and Work Analysis in Hospitals" by Büssing and Glaser (2002) in an adapted and validated general version. The response format ranged from 1 (*no, not at all*) to 5 (*yes, definitely*). To measure learning demands, *cognitive demands* and *learning requirements* were selected. *Autonomy* (design-, activity-, and decision-latitudes) and *supervisor feedback* were included as task and social resources. Stressors were operationalized as *work overload* and *work interruptions*. Cronbach's Alpha (α) coefficients ranged from .68 to .95 (Table 1). Items are provided in Table 2.

To represent strain-related variables, four measures were adapted: (1) *intrinsic motivation* (Cook, Hepworth, Wall, & Warr, 1981; sample item: "I feel a sense of personal satisfaction when I do this job well"; 5-point scale from 1 = *no, not at all* to 5 = *yes, definitely*; α = .79); (2) *creative performance* (Zhou & George, 2001; sample item: "I suggest new ways to achieve goals or objectives"; 6-point scale from 1 = *never* to 6 = *very often*; α = .88); (3) *emotional irritation* (Mohr et al., 2006; sample item: "I get irritated easily, although I don't want this to happen"; 7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*; α = .82; and (4) *musculoskeletal pain* (Brähler, Hinz, & Scheer, 2008; sample item: "neck and shoulder pain", 5-point scale from 1 = *none* to 5 = *strong*; α = .79).

Additional variables were controlled for in the analysis: Sex (0 = male, 1 = female) and leadership position (0 = no, 1 = yes) were dummy-coded, age (years) and effective average working time (hours per week) were assessed as continuous variables.

[insert Table 1 and Table 2 about here]

Data analyses

Analysis of missing data revealed that two items of the learning requirements scale had missing values of 20% and effective working hours were not provided on 29.5 % of surveys. For all other items, missing values ranged between 0 and 8.6 %. As listwise deletion can lead to biased estimates and reduced statistical power, multiple imputation of data was used (van Buuren, 2012). Based on the fully conditional specification approach, five imputed data sets were generated with the software R. Following procedures recommended by van Buuren and Groothuis-Oudshoorn (2011), all imputed variables showed healthy convergence with means and standard deviations close to the original data.

Data were analyzed through structural equation modeling (SEM). Confirmatory factor analysis (CFA) was used to establish the measurement model of latent variables. To test the first hypothesis, different CFA models of work characteristics were compared. Hypothesized effects of work characteristics (H2-H7) were tested in a structural model. Analyses were performed with the software Mplus 7. Conventional fit indices and cutoffs were examined (Kline, 2011). Relative chi-square ($\chi 2/df$) should not exceed 3.0. For Tucker-Lewis index and comparative fit index values above .90 are satisfactory. A standardized root mean square residual above .09 indicates misspecification and root mean square error of approximation of .05 or below indicates good fit.

Mediation effects were analyzed through the product-of-coefficients approach in conjunction with Sobel-test (Aroian version) and adjusted critical z-values (z´) as recommended by MacKinnon, Lockwood, Hoffman, West, and Sheets (2002). Additionally, we computed 95% confidence intervals for indirect effects, using the distribution-of-product method (Tofighi & MacKinnon, 2011). Direct paths were consecutively added to assess whether an effect was fully or partially mediated (Baron & Kenny, 1986).

Results

Hypothesis 1: Categorization of work characteristics

Hypothesis 1 postulates a tripartite taxonomy of work characteristics. Since learning demands, work-related resources, and stressors are each represented by two constructs each, we modeled them as second-order factors. CFA results are shown in Table 3. We also tested a single-factor model and two two-factor models with learning demands subsumed under either resources or stressors. Supporting the proposed tripartite structure, the three-factor second-order model displayed best fit to the data.

Second-order factors of learning demands and stressors showed high factor loadings (λ between .70 and .93, $p < .001$). The second-order resources factor pooled only a small proportion of variance (supervisor feedback: $\lambda = .19$, $p = .03$; autonomy: $\lambda = .38$, $p = .01$), indicating that first-order constructs do not properly converge into a common factor. Disaggregating the second-order resources factor into two first-order factors improved model fit (Table 3). Although fit indices further improved for a six factor model, in which all three second-order factors were disaggregated into first-order constructs, we decided against this alternative to remain close to the hypothesized tripartite structure.

The final measurement model of work characteristics thus consists of two second-order factors for learning demands (cognitive demands and learning requirements), and stressors (work overload and work interruptions), and two separate first-order resources factors (supervisor feedback and autonomy). Psychometric properties of the revised measurement model indicated close fit.

[insert Table 3 and Figure 2 about here]

Hypotheses 2 to 7: Short- and long-term outcomes of work characteristics

Before conducting multivariate tests, we examined the zero-order correlations, presented in Table 1. The pattern of correlations was generally in the expected direction.

Based on the final measurement model of work characteristics, hypotheses H2 to H5 were tested in the structural model. We specified direct paths from learning demands on intrinsic motivation (H2), from stressors on emotional irritation (H4), and from both resources factors (supervisor feedback and autonomy) on both intrinsic motivation and emotional irritation (H3 and H5). Further, paths from the proposed mediators (intrinsic motivation and emotional irritation) on the long-term outcomes (creativity and musculoskeletal pain) were included. In addition to independent variables, the two mediators were allowed to correlate. Finally, direct paths were specified from control variables (age, sex, leadership position, and effective work time) on all mediating and outcome variables.

The resulting model, depicted in Figure 2, fit the data well. Inclusion of control variables decreased model fit (Table 3), but did not affect structural paths. Table 4 presents effects of control variables. Women reported higher intrinsic motivation, emotional irritation, and musculoskeletal pain than men. Holding a leadership position was associated with higher scores of creativity and less musculoskeletal pain. The pattern of significant direct effects among latent variables fulfilled preconditions for statistical mediation. Multiple squared correlations of .16 for the positive and .34 for the negative chain suggest acceptable explanatory power. Table 5 summarizes results of the mediation analyses. In all cases, *p*-values of indirect effects were consistent with CIs.

[insert Table 4 about here]

As proposed in H2 and H3, high learning demands ($\beta = .15$, $p < .01$), supervisor feedback ($\beta = .21$, $p < .01$), and autonomy ($\beta = .20$, $p < .01$) were associated with intrinsic motivation, which, in turn, predicted creativity ($\beta = .34$, $p < .01$). Intrinsic motivation mediated positive indirect effects of learning demands ($\beta = .05$, $p < .01$), supervisor feedback ($\beta = .07$, $p < .01$), and autonomy ($\beta = .07$, $p < .01$) on creativity. Including directs paths from

learning demands and autonomy on creativity improved model fit, establishing partial mediation, whereas the effect of supervisor feedback was fully mediated.

As postulated in H4 and H5, high job stressors (β = .37, $p < .01$), low supervisor feedback (β = -.15, $p < .01$), and low autonomy (β = -.11, $p = .01$) were associated with emotional irritation, which predicted musculoskeletal pain (β = .52, $p < .01$). Irritation mediated indirect effects of stressors (β = .19, $p < .01$), supervisor feedback (β = -.08, $p < .01$), and autonomy (β = -.06, $p < .01$) on musculoskeletal pain. Partial mediation was established for feedback, and full mediation for stressors and autonomy.

[insert Table 5 about here]

Additional analyses

To support the validity of our results we conducted additional analyses (summarized in Table 3). First, to address reverse causality, we examined an alternative model with independent variables and outcomes reversed. Fit of this alternative model 1 was acceptable, but inferior to the hypothesized structure. Second, we explored effects of learning demands on the negative health chain and of job stressors on the positive health chain in alternative models 2 and 3. While model fit remained either stable or worsened slightly, an additional effect of stressors on intrinsic motivation was found in model 3.

Discussion

Work environments today pose new challenges for the design of healthy work. Organizations increasingly adapt flexible structures and new forms of work. For employees this implies new opportunities for personal development and growth (Spreitzer, Sutcliffe, Dutton, Sonenshein, & Grant, 2005), but also increased risks for work-related strain and health impairment (Eurofound, 2010).

We proposed an integrated model which differentiates learning demands, work-related resources, and job stressors. Differential relationships with short- and long-term outcomes of

motivation and creative performance as well as irritation and musculoskeletal pain were tested through SEM. Theoretical assumptions were largely supported, especially with regard to processes of personal development and health impairment. The tripartite taxonomy of learning demands, work-related resources and job stressors was superior to alternative two-factor models of job demands and resources. However, because work-related resources failed to integrate into a second-order factor, we departed from a strict tripartite structure by including the respective constructs as separate factors. While autonomy and supervisor feedback both function as resources, they appear to do so through largely independent processes.

Our model strengthens Karasek's (1979) claim of the learning function of work. Learning and personal development are important preconditions to succeed in today's rapidly changing work environments. Problem-solving and learning requirements of work tasks in restructured social and organizational processes are crucial for motivation and creative performance. However, we also observed a close association between learning demands and job stressors ($r = .50$, $p < .01$), suggesting a pattern of work intensification.

In contrast, the negative covariation of intrinsic motivation and emotional irritation ($r = .32$, $p < .01$) supports the assumed incompatibility between positive and negative health outcomes, illustrating the necessity to monitor both processes – personal development and health impairment due to work design. Challenging work tasks and learning requirements may be detrimental to health if this improvement is accompanied by work overload. This interpretation corresponds with observed trends of work intensification and acceleration (Rosa & Scheuerman, 2009), which have been empirically examined as "new demands" of work (Kubicek, Korunka, & Ulferts, 2013).

Moreover, we found a negative correlation between supervisor feedback and job stressors ($r = -.24$, $p < .01$), which hints at the responsibility of supervisors in protecting

employees from detrimental working conditions (e.g., assignment of suitable work tasks, attainable workload). To do so, supervisors must not only possess the necessary decision latitude, but also be aware of their function as a role model and work system designer to implement health-promoting conditions. Missing or "bad" supervisor feedback might lead to inadequate work processes and, therefore, more interruptions and work overload.

Preventing health impairment at work is the traditional perspective of work design. Maintaining and improving the working ability of the (ageing) workforce is a main societal issue in times of globalization, work intensification, and organizational restructuring. Our study demonstrates the utility of the proposed taxonomy of work characteristics above and beyond the bipartite structure currently dominating the literature. However, we had to further differentiate work-related resources and found unexpectedly high correlations between work characteristics, suggesting that further conceptual and empirical work is required.

Limitations

Several limitations warrant discussion. As we relied exclusively on self-reports, common method bias may be a concern. Although CFA results indicate that common method variance is not a major threat, post-hoc statistical remedies do not substitute the use of different data sources. A conceptual argument against common method bias is that work characteristics were assessed as condition-related constructs, whereas outcomes were person-focused. Thus, CMV is more likely to affect associations within rather than between these two groups of variables.

Second, cross-sectional data limit causal inferences. Mediated effects may reflect processes other than the hypothesized associations. Impairment of individual health or personality development might negatively affect the evaluation of work characteristics (e.g., Hornung, Weigl, Glaser, & Angerer, 2013). Alternatively, the attainment of mastery may reduce learning demands (Taris, Kompier, Geurts, Houtman, & Heuvel, 2010). Although it is

implausible to assume strictly unidirectional processes in increasingly dynamic work environments, the predominant causal direction from work characteristics on psychological responses forms the central tenet of work design research. Reverse causality thus is a minor concern in this study. We interpret the fact that a reverse causal model also had acceptable psychometric properties in terms of the need for a strong theoretical foundation and an orientation towards practical relevance. There should not be any doubt that, for the purpose of work design, the direction of effects in our model is more relevant than reverse associations.

Third, potential sources bias are connected to our sampling procedure. We analysed a heterogeneous and recently drawn sample, which reflects a broad cross-section of modern work in Germany, yet we caution that this is only a single convenience sample, which is not statistically representative. Moreover, we used an online questionnaire – a method often viewed as susceptible to sampling restrictions (e.g., internet access), self-selection-effects (e.g., computer literacy), and other biases (e.g., multiple or illicit participation; Wright, 2006). We addressed these concerns by restricting access to employees from participating organizations and registered users confirmed to be part of the working population. Nonetheless, generalizability remains subject to replication and validation studies.

Our long-term indicator for ill-health was musculoskeletal disorders, a common work-related health problem. Future research should include other health disorders (e.g., depression, burnout), but also consider work system outcomes (e.g., sick-leave, absenteeism) and/or alternative indicators of learning and job performance (e.g., knowledge increase, service quality). Irritation reflects impaired work-related recovery, but not individual capacity for recovery or detachment at work. Additionally, personal recovery activities (e.g., sports or hobbies) may reduce progression of job strain (Geurts & Sonnentag, 2006). Since our focus was on generic work design, we refrained from including individual factors (e.g., health behavior), but encourage research in that direction. Finally, alternative configurations of

learning demands (e.g., cooperation requirements), work-related resources (e.g., team climate), and job stressors (e.g., job insecurity) should be investigated to strengthen support for the broader framework.

Implications

Work design research needs to be more specific in predicting the impact of certain work characteristics on personality development and health. Stressors refer to harmful and health-impairing working conditions, such as work overload, information problems, work interruptions, work insecurity, and social conflicts. The definition of stressors should not be in the "eye of the beholder", but oriented on objective conditions, which are independent of the individual appraisal of employees. Work design needs to commit to the explicit goal to reduce such stressors at work.

Work characteristics should stimulate learning and performance, not only for "high potentials" and workers who evaluate learning demands as "challenges", but for all jobs and employees. Neglecting learning demands in cases of employees regarding them as "hindrance stressors" instead of "challenge demands" may lead to processes of dequalification, unlearning, and declining in cognitive skills and work-ability. Preconditions are adequate qualification, assignment to suitable tasks, and consideration of individual needs. Relationships between work characteristics and learning can change over time, requiring the adoption of dynamic and life-span perspectives (de Lange et al., 2010).

The adaptation of transactional stress theory (Lazarus & Folkman, 1984) for work design is unfit to define good work independently of individual appraisal processes. In contrast, ART provides a normative evaluation framework, independent of the subjective appraisal of individuals. Although people are different, well-qualified persons should be able to perform their work without experiencing overload, information problems, or interruptions.

Although some individuals might cope more successfully with work stressors than others, offloading the risk of health impairment to employees is irresponsible. Adequate thresholds for work characteristics need to be determined by work design experts. Recommendations derived from the introduced model are to increase learning demands, to strengthen work-related resources and to eliminate job stressors to develop motivation and performance and maintain worker health.

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Table 1

Means, standard deviations, Pearson zero-order correlations, and internal consistencies.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Control variables																
1 Age (years)	39.67	11.76	-													
2 Sex (0 = male; 1 = female)			-.15**	-												
3 Leadership position (0 = no; 1 = yes)			.18**	-.14**	-											
4 Effective working time (hours per week)	39.72	12.57	.10*	-.21**	.25**	-										
Work characteristics (independent variables)																
5 Cognitive demands	3.88	0.89	.06	-.18**	.26**	.22**	(.81)									
6 Learning requirements	3.36	0.86	-.03	-.05	.18**	.18**	.52**	(.68)								
7 Autonomy	3.36	0.90	.20**	-.07*	.27**	.16**	.32**	.28**	(.74)							
8 Supervisor feedback	2.76	1.20	-.16**	.05	.10**	.02	.01	.16**	.08	(.95)						
9 Work overload	3.12	0.96	.09*	-.13**	.17**	.17**	.36**	.20**	-.02	-.20**	(.84)					
10 Work interruptions	2.98	1.00	.04	-.11**	.16**	.16**	.32**	.16**	.04	-.14**	.51**	(.77)				
Short-term strain-related variables (mediators)																
11 Intrinsic motivation	4.20	0.73	.06	.06	.08	.09	.17**	.19**	.21**	.20**	-.08*	-.04	(.79)			
12 Emotional irritation	2.95	1.42	.02	.06	.06	.02	.10**	.05	-.08*	-.21**	.35**	.21**	-.28**	(.82)		
Long-term strain-related variables (outcomes)																
13 Creativity	3.90	1.02	.05	-.07	.22**	.14**	.30**	.31**	.30**	.13**	.03	.08	.28**	-.08*	(.88)	
14 Musculoskeletal pain	2.26	1.03	-.05	.24**	-.09	-.11*	-.06	-.07*	-.22**	-.13**	.19**	.16**	-.25**	-.12**	.45**	(.79)

Note. $N = 830$; matrix diagonal (in parentheses): Cronbach's alpha; *M* = mean; *SD* = standard deviation. * $p < .05$, ** $p < .01$.

Table 2

Items of work characteristics scales.

Scale	Item wording [German]
Cognitive demands:	
cd1	My work requires weighing various aspects in order to complete my tasks. [Meine Arbeit erfordert, immer wieder Verschiedenes abzuwägen, ehe ich Aufgaben erledigen kann.]
cd2	There are always difficulties arising in my work which I have to consider in-depth to overcome them. [Bei meiner Arbeit treten immer wieder Schwierigkeiten auf, bei denen ich gründlich überlegen muss, wie ich sie lösen kann.]
cd3	My work requires reacting to unpredictable developments regularly. [Meine Arbeit erfordert, immer wieder auf unvorhersehbare Entwicklungen zu reagieren.]
Learning requirements:	
lr1	In my work I have to acquire new theoretical knowledge regularly. [Ich muss immer wieder neues Fachwissen erwerben.]
lr2	In my work I have to acquire new social skills regularly. [Ich muss immer wieder neue soziale Fähigkeiten erwerben.]
lr3	In my work I have to acquire new technical skills regularly. [Ich muss immer wieder neue praktische Fertigkeiten erwerben.]
Supervisor feedback:	
sf1	My supervisor provides explicit feedback about my work performance. [Mein/e Vorgesetzte/r gibt mir klare Rückmeldung zu meiner Arbeitsleistung.]
sf2	My supervisor provides explicit feedback about my work behavior. [Mein/e Vorgesetzte/r gibt mir klare Rückmeldung zu meinem Arbeitsverhalten.]
sf3	My supervisor provides explicit feedback about my work results. Mein Vorgesetzter gibt mir klare Rückmeldung zu meinen Arbeitsergebnissen.
Autonomy:	
a1	My work offers discretion on how to do my work. [Ich kann selbst festlegen, wie ich meine Arbeit erledige.]
a2	My work allows for making decisions on which tasks I have to perform. [Ich kann selbst entscheiden, welche Aufgaben ich zu erledigen habe.]
a3	My work permits using my own ideas. [Ich kann bei der Erledigung der Aufgaben kreativ sein.]
Work overload:	
wo1	Even in a constant hurry, the amount of work is frequently too high to complete. [Ich muss mich immer wieder sehr beeilen und werde trotzdem nicht mit meiner Arbeit fertig.]
wo2	Frequently, there is too much work at once. [Ich habe bei der Arbeit immer wieder zuviel auf einmal zu tun.]
wo3	Frequently, there is time pressure due to short-time deadlines. [Ich habe bei der Arbeit wegen kurzfristigen Terminvorgaben immer wieder Zeitdruck.]
Work interruptions:	
wi1	I often have to interrupt my work due to other persons' requests. [Ich muss die Arbeit immer wieder unterbrechen, weil andere Personen ein Anliegen haben.]
wi2	I often have to interrupt my work due to phone calls / beepers. [Ich muss die Arbeit immer wieder unterbrechen, weil Telefon / Piepser klingeln.]
wi3	I often have to interrupt my work due to the unavailability of required persons. [Ich muss die Arbeit immer wieder unterbrechen, weil benötigte Personen nicht erreichbar sind.]

Table 3
Fit indices for CFAs and SEMs.

Model	χ^2	df	χ^2/df	CFI	TLI	SRMR	RMSEA [CI]
CFA: WC – 1 factor	3926.63	135	29.09	.32	.23	.169	.184 [.179; .189]
CFA: WC – 2 factors[a]	3103.97	134	23.16	.47	.39	.145	.163 [.158; .168]
CFA: WC – 2 factors[b]	2042.44	134	15.24	.66	.61	.136	.131 [.126; .136]
CFA: WC – 3 second-order factors	384.15	126	3.05	.96	.94	.065	.050 [.044; .055]
CFA: WC – 2 second-order factors, 2 first-order factors	362.65	125	2.90	.96	.95	.050	.048 [.042; .054]
CFA: WC – 6 first-order factors	338.17	120	2.82	.96	.95	.044	.047 [.041; .053]
SEM: structural model (without controls)	859.68	386	2.23	.95	.94	.066	.038 [.035; .042]
SEM: structural model (with controls)	1187.47	490	2.42	.93	.92	.074	.041 [.038; .044]
SEM: alternative model 1 (LTS → STS → WC; with controls)	1260.66	487	2.59	.92	.91	.082	.044 [.041; .047]
SEM: alternative model 2 (LD and S swapped; with controls)	1222.49	490	2.50	.92	.91	.077	.042 [.039; .045]
SEM: alternative model 3 (each STS variable regressed on both LD and S; with controls)	1176.01	488	2.41	.93	.92	.073	.041 [.038; .044]

Note. LD = learning demands; S = stressors; WC = work characteristics; STS = short-term strain; LTS = long-term strain; χ^2 = chi-square discrepancy; df = degrees of freedom; χ^2/df = relative chi-square; CFI = comparative fit index; TLI = Tucker-Lewis index; SRMR = standardized root mean square residual; RMSEA = root mean square error of approximation; CI = 90% confidence interval for population RMSEA.
[a] model with learning demands as resources. [b] model with learning demands as stressors

Table 4

Standardized path coefficients of controls on mediators and dependent variables.

Control variable	Intrinsic motivation	Emotional irritation	Creativity	Musculoskeletal pain
Age (years)	.07	-.02	-.02	.03
Sex (0 = male; 1 = female)	.12**	.11**	-.07	.19**
Leadership position (0 = no; 1 = yes)	-.03	.07	.18**	-.09*
Effective working time (hours)	.07	-.02	.06	-.06

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

Table 5

Mediated effects.

Direct effect 1 (A → B)	β [*B*; *SE*]	Direct effect 2 (B → C)	β [*B*; *SE*]	Indirect effect (A → C)	β[a] [*B*; *SE*]	*z´* [b]	95% CI [LL; UL]	$\Delta\chi^2$ Direct effect 3 (A → C) [β] [c]
Learning demands → Intrinsic motivation	.15** [.15; .05]	Intrinsic Motivation → Creativity	.34** [.51; .07]	Learning demands → Creativity	.05** [.08; .03]	2.66	[.01; .09]	48.65** [.31]
Supervisor feedback → Intrinsic motivation	.21** [.12; .02]	Intrinsic Motivation → Creativity	.34** [.51; .07]	Supervisor feedback → Creativity	.07** [.06; .01]	4.11	[.04; .11]	1.09 n.s. [.04]
Autonomy → Intrinsic motivation	.20** [.18;.05]	Intrinsic Motivation → Creativity	.34** [.51; .07]	Autonomy → Creativity	.07** [.06; .03]	3.21	[.03; .11]	33.96** [.28]
Stressors → Emotional irritation	.37** [.58; .08]	Emotional irritation → Musculo-skeletal pain	.52** [.38; .04]	Stressors → Musculo-skeletal pain	.19** [.22; .04]	5.71	[.14; .24]	3.54 n.s. [.08]
Supervisor feedback → Emotional irritation	-.15** [-.16; .05]	Emotional irritation → Musculo-skeletal pain	.52** [.38; .04]	Supervisor feedback → Musculo-skeletal pain	-.08** [-.06; .02]	-3.32	[-.12; -.04]	22.24** [-.19]
Autonomy → Emotional irritation	-.11** [-.20; .08]	Emotional irritation → Musculo-skeletal pain	.52** [.38; .04]	Autonomy → Musculo-skeletal pain	-.06** [-.08; .03]	-2.48	[-.11; -.01]	1.06 n.s. [-.03]

Note. β = standardized regression weight; *B* = unstandardized regression weight; *SE* = standard error. * $p < .05$, ** $p < .01$.
[a] statistical significance based on critical z´-values (MacKinnon et al., 2002: $p < .01$ for $z > 1.10$; $p < .05$ for $z > .097$). [b] test statistic calculated from Aroian version of the Sobel test. [c] change in model chi-square by adding the specified path (corresponding standardized regression weight in brackets).

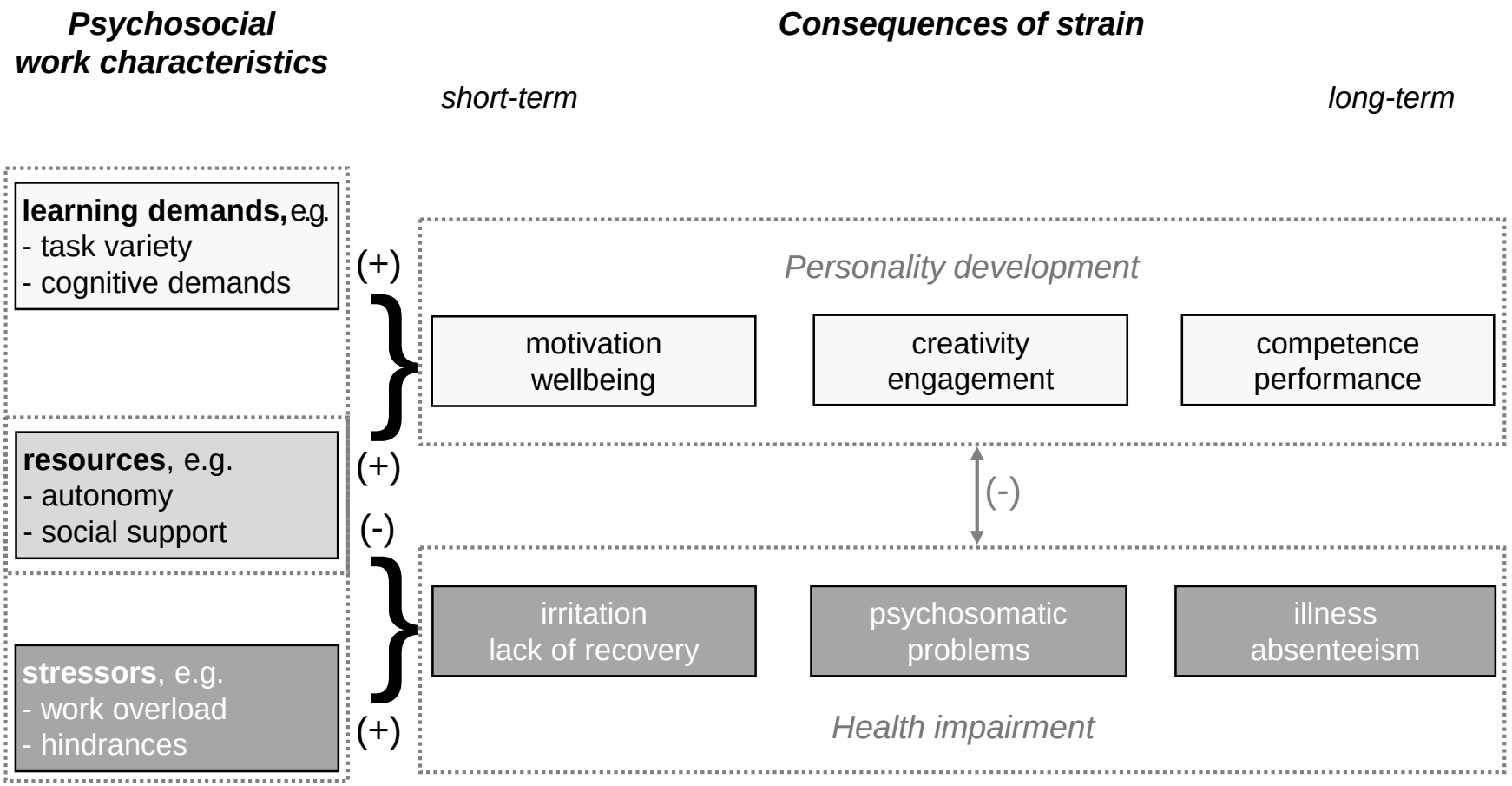

Figure 1. Proposed model of psychosocial work characteristics and consequences of strain.

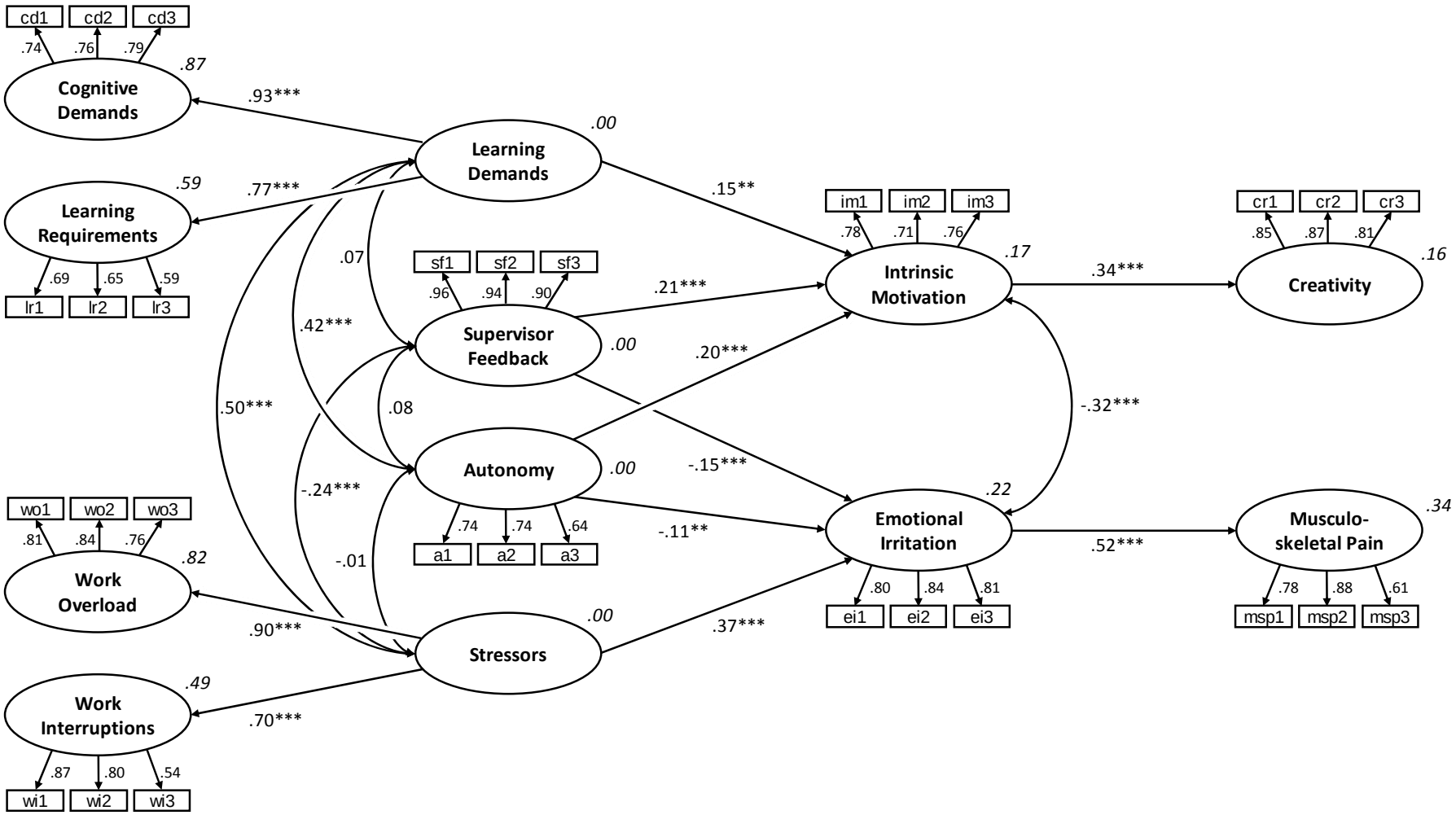

Figure 2. Structural equation model for the test of the proposed model.

Note. N = 830; standardized coefficients are reported; italics denote explained variance; controls: age, sex, leadership position, working time. * $p < .05$, ** $p < .01$, *** $p < .001$.