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Lifespan and Learning Perspectives on Work Design

A Three-Study Investigation of the Relationships Between Job Characteristics, Health, Informal Workplace Learning, and Occupational Future Time Perspective

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Summary

To successfully meet the challenges both of an aging workforce and increased learning needs, the dissertation examines work design from a lifespan, a learning, and a combined perspective. I conducted a literature review, a conceptual study, and an empirical study to explore how the design of work environments can promote employee health, informal workplace learning, and occupational future time perspective (OFTP).

In Study 1 (the literature review), I examined job characteristics in view of employees' health from a lifespan perspective. For this, I analyzed how associations between psychosocial job characteristics (e.g., quantitative work demands, social support) and individual health vary across age groups (younger, middle-aged, and older employees). Thirty articles with 107 associations demonstrated significant evidence of interactions between job characteristics and age for most of the observed associations. While differences across three age groups have been observed (e.g., a stronger association between low job autonomy and poor health in older employees), no crossover interactions with contradictory associations between age groups have been identified. Therefore, the review highlights the need for an age-sensitive work design that considers employees' capabilities and needs across the lifespan. Tailoring job characteristics to age-related vulnerabilities has the potential to prevent effects of unhealthy working conditions.

Because workplaces become increasingly digital, job characteristics change as well. In Study 2 (the conceptual study), I investigated work design in telework arrangements from a learning perspective, based on the octagon model of informal workplace learning (Decius et al., 2019). For this, I developed a conceptual framework and integrated research findings to illustrate how telework modifies opportunities for informal workplace learning (IWL). It demonstrated why telework reduces opportunities for IWL due to social processes and role boundaries and increases opportunities via higher self-regulation needs. I specified opportunities on how supervisors could support employees' IWL by designing employees' work and accompanying learning processes, e.g., by organizing social exchange or providing learning cues and resources.

In Study 3 (the primary study), I examined work design from an integrated lifespan and learning perspective. The study used the process model of successful aging at work (Kooij et al., 2020) as an overarching framework and investigated job-related and personal antecedents of OFTP, and the role of job crafting as a self-regulation mechanism for OFTP. The two-wave data is based on responses from 184 white-collar workers and the results confirm occupational self-efficacy as a personal antecedent of OFTP and job crafting as a mediator. Contrary to the initial hypotheses, I found a positive indirect effect of OFTP on learning-related task characteristics via promotion-focused job crafting (and not vice versa), and a negative effect of OFTP on prevention-focused job crafting. The findings emphasized the importance of dynamic and adaptive work design so that proactive work design strategies (i.e., job crafting) and personal resources (i.e., occupational self-efficacy) enable a broadening of OFTP.

In sum, the results underline the importance of considering age-related developments, self-regulation behavior and reciprocal effects when investigating effects of work design. The studies provide evidence that future-oriented, high-quality work design should include age-sensitive, learning-oriented, and dynamic characteristics as well as interventions on multiple levels. This enables employees to adapt to changing working conditions through self-regulation and thus contribute to continuous learning and successful ageing at work.

Zusammenfassung

Um den Herausforderungen alternder Belegschaften und gestiegenen Lernbedarfen in einer sich zunehmend verändernden Arbeitswelt wirksam begegnen zu können, untersucht die Dissertation Arbeitsgestaltung aus der Perspektive der Lebensspanne, des Lernens und einer kombinierten Perspektive heraus. Ziel ist es, Ansatzpunkte herauszustellen, die die individuelle Gesundheit, informelles Lernen und die berufliche Zukunftsperspektive fördern.

Das systematische Literaturreview (Studie 1) untersucht Arbeitsmerkmale im Hinblick auf die Beschäftigtengesundheit aus der Perspektive der Lebensspanne. Im Fokus steht dabei, wie sich Assoziationen zwischen psychosozialen Arbeitsmerkmalen (z. B. quantitative Arbeitsanforderungen, soziale Unterstützung) und individueller Gesundheit in drei Altersgruppen unterscheiden (jüngere, mittelalte und ältere Beschäftigte). Die Analyse von 30 Artikeln mit insgesamt 107 korrelativen Zusammenhängen ergibt mehrheitlich signifikante Interaktionen zwischen Arbeitsmerkmalen und Alter. Während altersabhängige Unterschiede in den Assoziationen beobachtet werden (z. B. ein stärkerer Zusammenhang zwischen geringer Autonomie am Arbeitsplatz und schlechter Gesundheit bei älteren Beschäftigten), werden keine entgegengesetzten Interaktionen zwischen Arbeitsmerkmalen und Gesundheit für verschiedene Altersgruppen beobachtet. Dies unterstreicht, wie wichtig es ist, sowohl altersübergreifende als auch altersspezifische Entwicklungen systematisch bei der gesundheitsförderlichen Gestaltung von Arbeit zu berücksichtigen.

Die zunehmende Digitalisierung am Arbeitsplatz verändert Merkmale von Arbeit teilweise grundlegend. In der konzeptionellen Studie (Studie 2) wird Arbeitsgestaltung im Kontext von Telearbeit aus der Perspektive des informellen Lernens untersucht. Die Grundlage für diese Studie bildet das Oktagon-Modell des informellen Lernens am Arbeitsplatz (IWL; Decius et al., 2019). Der für diese Studie entwickelte konzeptionelle Rahmen integriert bestehende Forschungsergebnisse und veranschaulicht, wie Telearbeit Bedingungen für IWL verändert. Danach schränkt Telearbeit Möglichkeiten für IWL aufgrund veränderter sozialer Prozesse und

Rollengrenzen ein und fördert sie durch höhere Anforderungen an die Selbstregulation. Außerdem wird herausgearbeitet, wie Vorgesetzte IWL auf verschiedenen Ebenen unterstützen können, indem sie Arbeitsbedingungen gestalten und individuelle Lernprozesse begleiten, z. B. durch die Organisation des sozialen Austauschs oder das Schaffen von Lernanlässen.

In der quantitativ-empirischen Studie (Studie 3) wird Arbeitsgestaltung aus einer integrierten lebensspannen- und lernbezogenen Perspektive untersucht. Als theoretisches Rahmenmodell dient das Prozessmodell des erfolgreichen Alterns am Arbeitsplatz (Kooij et al., 2020). Analysiert werden arbeitsplatzbezogene und persönliche Einflussfaktoren auf die berufliche Zukunftsperspektive (Occupational Future Time Perspective, OFTP), sowie die Rolle von Job Crafting als Selbstregulationsstrategie für OFTP. Die Datenerhebung erfolgt in zwei Wellen, basierend auf Antworten von 184 Angestellten. Die Ergebnisse bestätigen berufliche Selbstwirksamkeit als persönlichen Einflussfaktor für OFTP und Job Crafting als Mediator. Entgegen der ursprünglichen Annahme zeigt sich ein positiver indirekter Effekt von OFTP auf lernförderliche Arbeitsmerkmale – vermittelt über annäherungsorientiertes Job Crafting (und nicht in die entgegengesetzte Richtung) – und ein negativer Effekt von OFTP auf vermeidungsorientiertes Job Crafting. Die Ergebnisse unterstreichen die Bedeutung einer dynamischen und adaptiven Arbeitsgestaltung, bei der sowohl proaktive Strategien der Arbeitsgestaltung (d.h. Job Crafting) als auch persönliche Ressourcen (d.h. berufliche Selbstwirksamkeit) ein erfolgreiches Altern am Arbeitsplatz unterstützen können.

Zusammenfassend unterstreichen die Ergebnisse, dass altersbezogene Entwicklungen, Selbstregulation und reziproke Effekte bei der Untersuchung von Auswirkungen von Arbeitsgestaltung berücksichtigt werden sollten. Eine zukunftsorientierte Arbeitsgestaltung sollte altersgerechte, lernförderliche und dynamische Merkmale beinhalten. Dies ermöglicht Beschäftigten, sich durch Selbstregulation an sich verändernde Arbeitsbedingungen anzupassen und damit zum kontinuierlichen Lernen und erfolgreichen Altern beizutragen.

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List of Abbreviations

ARAL	action regulation across the adult lifespan
ART	action regulation theory
CFI	comparative fit index
ERI	effort–reward imbalance model
Df	degrees of freedom
HWE	healthy worker effect
HWSB	healthy worker survivor bias
IWL	informal workplace learning
JD-R	job demands–resources model
M	mean
MTD	motivational theory of lifespan development
OFTP	occupational future time perspective
RMSEA	root mean square error of approximation
SD	standard deviation
SRMR	standardized root mean square residual
SST	socioemotional selectivity theory
WDGM	work design growth model

"Losing the ability to learn is not exclusively related to age, but is normally the result of a working biography with a lack of continuous learning demands and, in particular, opportunities to learn." (European Agency for Safety and Health at Work, 2007, p. 70)

1. Introduction

The world of work is experiencing profound changes with aging workforces and worker shortages in many developed countries and industries. In this context, it is essential for both research and practice to promote successful aging at work and to understand how working conditions enable employees to remain healthy and engaged throughout their careers (Beier et al., 2022). Beyond demographic shifts, the nature of work itself is undergoing significant transformations driven by increasing digitalization, enhanced flexibility, heightened employee participation, and the blurring of traditional work boundaries (Graßmann & Decius, 2023). To effectively respond to these transformations, learning and development serve as an essential mechanism enabling employees to adapt to these changes (Tannenbaum & Wolfson, 2022). Accordingly, continuous learning[1] is typically conceptualized as a current and future requirement to remain productive at work. Specifically, informal workplace learning (IWL) is becoming crucial for employees' and organizations' adaptability (Beier et al., 2025; Schulte et al., 2020).

Work design is a powerful tool in both of these contexts – promoting successful aging and addressing continuous informal learning (Cadiz et al., 2019a; Parker, 2017). Well-designed work is an effective tool because it affects not only work motivation and job performance, but also health, cognition, and well-being (Humphrey et al., 2007; Parker et al., 2021). Although initiatives at national and organizational levels have successfully contributed

[1] In the following, I will use "continuous learning" instead of "lifelong learning" to avoid the implicit emphasis on older workers (cf. Griep et al., 2025). More specifically, I will primarily refer to "continuous informal learning", because my research focuses on informal learning.

to healthier workplaces, poor working conditions still persist, with a simultaneous increase in psychosocial risks (Parker & Zhang, 2016; Rigó et al., 2021; Schulte et al., 2020). Therefore, further research is necessary to deepen the understanding of the interplay between work design, successful aging, and IWL (Scheibe & Kooij, 2024; Parker et al., 2021; Zacher & Froidevaux, 2021).

To address these issues, my dissertation examines work design from perspectives that go beyond traditional approaches of work design. The *lifespan perspective on work design* addresses the interplay between age and job characteristics throughout the career (Zacher et al., 2019). The *learning perspective on work design* is based on the understanding that working conditions can either facilitate or impede informal workplace learning (Beier et al., 2017; Parker, 2017). The *integration of both perspectives* provides a more comprehensive understanding of how job characteristics, age-related concepts, and IWL are interconnected.

Guided by this framework, I focus on three core research questions. These address 1) the role of chronological age within the relationship between psychosocial job characteristics and health; 2) the relationship between "new work characteristics" (i.e., telework) and informal learning, and specifically the role of supervisors therein; and 3) the relationships between learning-related task characteristics and occupational future time perspective (OFTP), and the role of job crafting within.

The dissertation provides theoretical and empirical insights into work design from a lifespan, a learning, and a combined perspective. It introduces the research questions and outlines the three studies that form the basis of this dissertation. Finally, it discusses their findings and implications.

2. Lifespan and learning perspectives on work design

Work design encompasses attributes of the task, job, and as well as social and environmental factors (Morgeson & Humphrey, 2006), and it remains a topic of ongoing interest for both researchers and practitioners (Oldham & Fried, 2016). While early work

design research primarily focused on optimizing job performance and efficiency (i.e., Taylor, 1911), later developments also included outcomes of interest like work motivation, job satisfaction, and turnover intentions (e.g., Hackman & Oldham, 1976). However, work design research from a lifespan perspective (which goes beyond a focus on "older workers") and from an informal learning perspective (which goes beyond a beyond traditional training and development) has only recently been initiated (e.g., Truxillo et al, 2012; Wielenga-Meijer et al., 2010).

In the following, I present theoretical and empirical considerations of work design from a lifespan, a learning, and an integrated perspective, before outlining the objectives and research questions of my dissertation.

2.1 Work Design from a Lifespan Perspective

Scholars adopted lifespan perspectives in occupational research to examine how age-related processes affect behavioral, attitudinal, and well-being outcomes at work (Zacher & Froidevaux, 2021). Lifespan approaches view human development as a multidirectional, lifelong, and continuous process, with no single age period being more relevant than another (Baltes, 1987; Zacher et al., 2019). As a meta-theory, it suggests that individuals actively adapt to age-related changes by directing their resources towards developments of growth, maintenance, and the regulation of losses (Baltes et al., 1999). The most influential lifespan theories in occupational research include socioemotional selectivity theory (SST, Carstensen et al., 1999), the model of selection, optimization, and compensation (Baltes & Baltes, 1990), and the motivational theory of lifespan development (MTD, Heckhausen et al., 2010).

Lifespan development approaches have been primarily applied to individual outcomes, such as work motivation, job satisfaction, health, and performance (Rudolph, 2016; Zacher et al., 2019), without examining the role of work design in detail (Cadiz et al., 2019a). However, the lifespan perspective on work design aims at understanding the role of job characteristics on individual experiences and behaviors as a function of individual changes that occur across

the lifespan (Zacher et al., 2016) and how they can contribute to aging successfully (Truxillo et al., 2014). For example, older employees benefit from their higher emotional expertise in working life – so they are able to control their emotions better in socially stressful situations compared with younger colleagues (Scheibe et al., 2015).

When studying aging at work, researchers and practitioners often rely on the most accessible measure of age, chronological age, although it is only an inadequate proxy of the complex aging processes influenced by biological, cognitive, social, and work-related factors (Beier et al., 2022; Kanfer & Ackerman, 2004). Consequently, recent research also applies alternative conceptualizations of age, including subjective, psychological, functional, and organizational age (Fraccaroli et al., 2017). An increasingly studied age-related concept is OFTP, which describes employees' perceptions of their remaining time and opportunities in their working lives (Zacher & Frese, 2009). Based on SST (Carstensen, 2006), OFTP is a cognitive-motivational variable and positively related to central work outcomes, such as work engagement, job satisfaction, and task performance. Given its positive association with employees' motivation to continue working after official retirement age, OFTP has become an important construct in research on aging at work (Rudolph et al., 2018).

A key approach within the lifespan perspective is the concept of successful aging at work, describing an individual's ability and motivation to continue working (Beier et al., 2022), and the interplay of personal factors (e.g., OFTP) and job characteristics (e.g., autonomy). For successful aging at work, employees proactively regulate the anticipated or experienced person–environment fit (Kooij et al., 2020). One mechanism of self-regulation is job crafting, which refers to self-initiated modifications that employees implement to enhance their person–environment fit (Beier et al., 2022). Consequently, job crafting represents a valuable construct for examining work design from a lifespan perspective.

2.2 Work Design from a Learning Perspective

The learning perspective on work design examines how working conditions can foster (informal) learning processes. Given today's dynamic work environment, both organizations and employees need to increasingly focus on continuous learning and improving skills and competences to remain competitive (Decius et al., 2024; Noe et al., 2014). Learning occurs in both formal and informal settings. While formal learning is typically standardized and guided by organizational and instructor input, IWL is problem-induced, self-directed, intentional, and field-based (Cerasoli et al., 2018). It arises from challenges inherent to the job task and contains elements of model learning, reflection, feedback, and the trying and application of new ideas (Decius et al., 2021c). Therefore, IWL is also described as “on-the-job-learning” (Clarke, 2004), and it stimulates cognitive, motivational, and behavioral processes and gains in acquisition of skills and performance (Cerasoli et al., 2018). Although the majority of learning at work takes place informally (Eraut, 2011; Noe et al., 2013) and it plays a more significant role in employee performance than formal training (De Grip, 2024), IWL has remained underrepresented in organizational practice and research (Tannenbaum & Wolfson, 2022).

Different learning theories emphasize the interaction between learning opportunities and individual engagement (e.g., model of workplace learning; Billett, 2004), specify structural conditions that enable or constrain workplace learning (e.g., expansive-restrictive framework; Fuller & Unwin, 2004), or describe the interplay between learning determinants, processes and outcomes (e.g., 3-P model of workplace learning; Tynjälä, 2013). However, few frameworks focus on IWL. Here, the octagon model of IWL (Decius et al., 2019) provides a structured typology of IWL activities, and the CAM-OS framework (Tannenbaum & Wolfson, 2022) includes personal and situational readiness factors.

In terms of work design, some frameworks have a focus on learning and development. Besides the job characteristics model (Hackman & Oldham, 1976), action regulation theory

(ART; Frese & Zapf, 1994; Hacker, 2003) conceptualizes employees as active learners, emphasizing that knowledge acquisition and skills development require action (Zacher & Frese, 2018). Task characteristics such as feedback and task identity (i.e., completeness of tasks) enable employees to engage in different phases of action regulation (e.g., goal setting, planning), which in turn promote learning and personality development (Zacher et al., 2016). The construct capturing these task characteristics is referred to as "learning-related task characteristics" (Richter & Wardanjan, 2000). Another framework, which addresses (informal) learning and development from a work design perspective is Parker's (2017) work design growth model (WDGM) which incorporates these characteristics as well and others (e.g., job complexity). The WDGM proposes that work design shapes learning outcomes via cognitive, behavioral, and affective mechanisms. Recent studies underline the significance of work design for learning behavior, showing that employees are more likely to engage in IWL when they have access to job-related resources such as job autonomy and support (Cerasoli et al., 2018; Decius et al., 2021b; Taris & Kompier, 2004; Wielenga-Meijer et al., 2010).

The rise of digitalization and the COVID-19 pandemic reshaped work design. The shift towards new work arrangements (e.g., telework) led to changes in organizational structures and social dynamics (Gajendran & Harrison, 2007; Wöhrmann & Ebner, 2021). Therefore, this modifies opportunities for IWL as well (Graßmann & Decius, 2023).

2.3 Work Design from an Integrated Lifespan and Learning Perspective

As outlined, a lifespan and a learning perspective on work design both have the potential to contribute to successful aging and continuous informal learning. A combined approach, which integrates both perspectives examines the intersection of aging and IWL.

Fluid cognitive abilities (e.g., information processing) begin to decline in early adulthood and continue to deteriorate across the lifespan. Therefore, learning new information becomes generally increasingly difficult when employees age (Crawford et al., 2010). However, crystallized abilities (e.g., knowledge, experience) can generally continue to

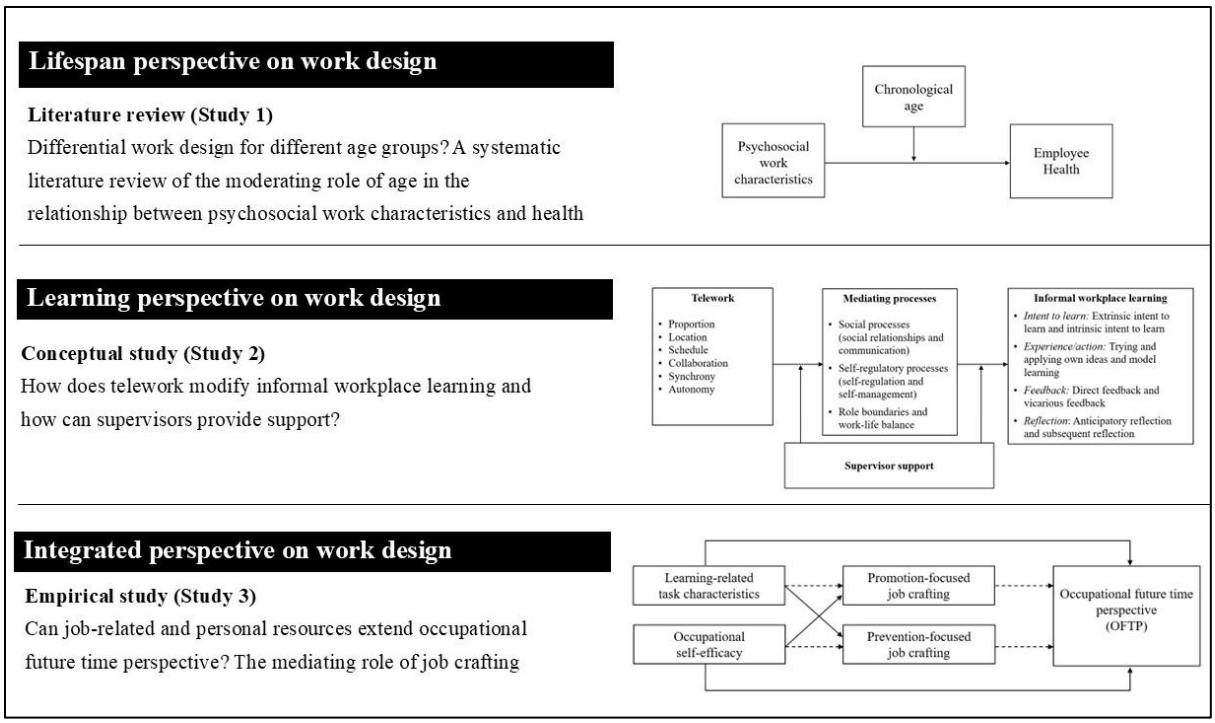
develop throughout the lifespan (Beier et al., 2025; Salthouse, 1991). Regarding IWL, studies show that older employees engage less frequently in IWL activities compared to younger employees (Cerasoli et al., 2018; Decius et al., 2021c; Decius et al., 2021b). However, chronological age alone does not fully explain this relationship. Instead, OFTP as a cognitive-motivational construct mediates age effects on key work outcomes, including employability and work performance (Henry et al., 2017). Additionally, OFTP is linked to learning-related variables, such as learning motivational beliefs and learning goal orientation (Kochoian et al., 2017; Kooij & Zacher, 2016). However, as employees age, they shift priorities from growth-related motives to emotional stability goals (Carstensen et al., 1999), leading to a decline in motivation for IWL. Specifically, OFTP emerged as a pivotal variable, even when job characteristics are considered. Job characteristics such as job complexity and job control can moderate the relationship between age and OFPT, alleviating their negative association (e.g., Zacher & Frese, 2009).

Notably, learning processes are not only determined by age; rather, learning opportunities themselves shape age-related processes: Job characteristics that are conducive to learning (e.g., job autonomy) are positively associated with work ability, health and well-being, and OFTP (Cadiz et al., 2019b; Parker et al., 2017b; Zacher & Frese, 2009; 2011). In other words, and in terms of ART (Frese & Zapf, 1994) and SST (Carstensen et al., 1999), job-related resources enable employees to regulate their actions at work and contribute to informal learning and development, thereby fostering OFTP. In addition to OFTP, job characteristics can also affect cognition across the lifespan such as knowledge or cognitive processes (Fisher et al., 2017; Zacher et al., 2016). This occurs through cognitive enrichment pathways (i.e., exploratory learning) in the short and medium term, and through cognitive preservation and accumulated knowledge in the longer term (Oltmanns et al., 2017; Parker et al., 2021). The dominant lifespan theoretical approach in this regard is the mental exercise hypothesis (Salthouse, 1991), suggesting that (working) conditions can buffer age-related

cognitive decline and contribute to successful aging (Zacher & Frese, 2018; Nilsen et al., 2022). In addition, the cognitive reserve hypothesis (Stern, 2012) proposes a protective mechanism, developed through lifelong mental stimulation (Then et al., 2014). Especially older workers and their intellectual flexibility benefit from mentally stimulating work (Fisher et al., 2014).

Figure 1

Research model of the dissertation



Finally, research also emphasizes reciprocal relationships between job characteristics, aging, and learning variables. While some research explores the mutual influence of age-related changes and work contexts (Scheibe & Kooij, 2024), others examine specifically reciprocal relationships between job characteristics and IWL (Decius et al., 2023b). For example, relationships between job characteristics and learning-related behavior is not only reciprocal but varies across age groups (De Lange et al., 2010). In sum, findings suggest that

future research should investigate the interplay between job characteristics and aging from different directions.

2.4 Objectives, Research Questions and Outline of the Dissertation

My dissertation comprises three interrelated studies that explore work design from a lifespan, a learning, and an integrative perspective. The studies aim to address challenges of an aging workforce and the increasing need for continuous informal learning (see Figure 1).

The impact of work design on employee's health and well-being is well-documented in both theoretical and empirical research (e.g., Bakker et al., 2023; Humphrey et al., 2007; Oldham & Fried, 2016). Simultaneously, age-related changes in health, cognition, personality, or motivation have been identified (e.g., Hertel & Zacher, 2015; Zacher & Froidevaux, 2021). This raises the question of whether age moderates the relationship between work design and employee health. While prior studies have been conducted on specific job characteristics (e.g., task variety; see Bos et al., 2013), there is currently a lack of comprehensive reviews from a lifespan perspective, focusing on age-sensitive associations. A systematic analysis could help to identify needs in view of an age-sensitive work design, which could contribute to employee health across the lifespan. Therefore, I propose the following research question:

Research question 1: Does the relationship between psychosocial job characteristics and employee health vary as a function of age?

To address this question, I conducted a systematic review of a large sample of relevant published research, analyzing the interaction between job characteristics and age in relation to employee health (Study 1).

Besides the consideration of a lifespan perspective on work design, I examine the relationship between working conditions and IWL, emphasizing the role of work design from an informal learning perspective. Prior research has demonstrated that job characteristics shape opportunities for IWL (Cerasoli et al., 2018). However, little is known about the role of "new work characteristics", such as those arising from teleworking arrangements (Graßmann

& Decius, 2023; Parker et al., 2017a), and how these affect IWL. Telework involves employees' separation from their traditional workplaces, altering spatial and temporal boundaries of work and its characteristics (Allen et al., 2003; Gajendran & Harrison, 2007). Furthermore, it is yet unclear how supervisors can effectively support IWL in telework settings (e.g. Cerasoli et al., 2018; Tannenbaum & Wolfson, 2022). Developing a framework that illustrates the impact of telework-related processes on IWL could help organizations and supervisors enhance opportunities for IWL. Hence, the second research question is:

Research question 2: How does telework modify IWL and how can supervisors facilitate support?

To address the second research question, I conducted a conceptual study in which I integrated relevant theories and empirical findings. This resulted in the development of a conceptual framework that demonstrates how telework-related job characteristics modify opportunities for IWL and how supervisors can provide effective support (Study 2).

The third research question integrates the lifespan and learning perspective on work design. In addition to examining psychosocial job characteristics (Study 1) and new work characteristics (Study 2), Study 3 investigates the relationship between learning-related task characteristics and OFTP. While the concept of learning-related task characteristics originates from ART (Zacher & Frese, 2018), its mechanisms remain insufficiently understood (Wielenga-Meijer et al., 2010). Empirical insights into how job-related resources (i.e., learning-related task characteristics) and personal resources (i.e., occupational self-efficacy) shape OFTP could facilitate a more comprehensive understanding of its antecedents and potential interventions. In line with the process model of successful aging at work (Kooij et al., 2020), self-regulatory processes may serve as a mediating mechanism in this relationship. In light of these considerations, the following question is proposed:

Research question 3: Do learning-related task characteristics and occupational self-efficacy affect OFTP, and does job crafting mediate the relationship?

To answer the third research question, I conducted an empirical study employing a cross-lagged panel design to analyze two-wave data from different organizations (Study 3).

In summary, the three research questions cover and integrate multiple perspectives on work design to provide a more comprehensive understanding of how job characteristics contribute to employee health, IWL, and OFTP, and therefore support successful aging and informal continuous learning. The references of the studies that form the dissertation can be found in Appendix A, and the contributions of the (co-) authors are presented in Appendix B.

3. Study 1 – Differential Work Design for Different Age Groups? A Systematic Literature Review of the Moderating Role of Age in the Relationship Between Psychosocial Work Characteristics and Health

Authors: Inga Mühlenbrock, Joachim Hüffmeier

3.1 Introduction

Occupational health research has increasingly focused on psychosocial hazards at work and has often found adverse effects on employees' well-being, attitudes, and behavior in meta-analytical studies (e.g., Fried & Ferris, 1987; Humphrey et al., 2007; Montano et al., 2017). Also, European occupational health and safety legislation has specified psychosocial risk assessment tools to reduce these hazards in organizational practice (Janetzke & Ertel, 2017), but the promotion of good psychosocial work characteristics continues to be important (e.g., Eurofound, 2017). For instance, a recent review reported the enormous financial burden of up to € 165 billion in 2014 caused by work-related stress, consisting of productivity-related losses as well as healthcare and medical costs (e.g., Hassard et al., 2018).

Simultaneously, workforces are changing in terms of demographic variables, for example, the proportion of older European employees in the total workforce (aged 55 – 64) is expected to rise from 17% in 2016 to 21% in 2030 (European Commission, 2017). Moreover, age spans have become larger, for instance, due to increasing rates in the employment of individuals aged 65 and older (European Commission, 2017). These developments raise important questions such as: Do older employees react to psychosocial work characteristics in a similar way to younger employees? Or do demographic changes contribute to a better understanding of the effects of working conditions on health? To answer these questions, a lifespan perspective on work design may help in identifying work factors that might affect younger and older employees differently.

We adopted this perspective to conduct a review of current findings on age-sensitive

associations between different psychosocial work characteristics and health. Related primary studies on isolated characteristics (e.g., task variety; Bos et al., 2013) have been issued, but psychosocial work characteristics have not been analyzed by pertinent reviews, meta-analyses, or an integrative synopsis. We thus provide a systematic literature review to summarize the pertinent findings on psychosocial work characteristics and thereby provide such a synopsis.

In the following, we first define the central constructs (i.e., psychosocial work characteristics, age, and employee health) and then present the current state of research. Subsequently, we introduce the pertinent theoretical approaches and develop our theoretical propositions separately for five psychosocial work dimensions. We then describe the methodological approach used in our review before presenting our findings. Finally, we discuss our findings and derive implications for future research and practice with a specific focus on age-sensitive work design.

3.2 Psychosocial Work Characteristics and Aging

3.2.1 Conceptualizations of the Central Constructs

Psychosocial work characteristics are generally defined as "[…] aspects of work design and the organization and management of work, and their social and environmental contexts" (Cox et al., 2000, p. 14). They are recognized as critical for health promotion owing to their potential to cause psychological, social, or physical harm (Cox et al., 2000; Kalimo, 1987; Rugulies, 2018). Research on psychosocial work characteristics (e.g., work organization, social relationships) has primarily focused on how these factors affect psychophysiological changes, health-related behaviors, or the risk of diseases (Rugulies, 2018). A frequently used classification of the psychosocial work environment is based on the Copenhagen Psychosocial Questionnaire (COPSOQ II; Pejtersen et al., 2010), which differentiates between the following five domains: (a) demands at work (e.g., work pace), (b) work organization and job contents (e.g., employee influence), (c) interpersonal relations and

leadership (e.g., support from colleagues and supervisors), (d) work–individual interface (e.g., job insecurity), and (e) values at the workplace (e.g., trust in management).

We conceptualize age as a central moderating variable that affects employees' reactions to psychosocial work characteristics. *Age* entails the individual process of aging and is usually operationalized via chronological age (i.e., time since birth) and as a continuous variable ranging from 18 to 65 years in occupational studies – the years typically spent in the workforce (Hertel & Zacher, 2015). Despite different conceptualizations of age (e.g., subjective age, functional age), we focus here on chronological age because it is the measure that most studies use. Studies considering age groups typically define *older workers* in relation to the median age of the study sample or relative to cut-offs that are specified by advocacy groups or legislation (e.g., 40 or 60 years; cf. Hertel & Zacher, 2015). According to the lifespan development perspective (Baltes et al., 2006), human development is conceived of as a lifelong process that involves both gains and losses and that includes major within-person changes concerning cognitive capacity, personality, goal orientation, social–emotional experience, and health, all of which also affect workplace experiences and behaviors in turn (cf. Ng & Feldman, 2013b). Extant aging research has usually covered the main effects of chronological age on employee health without considering work characteristics (e.g., Maertens et al., 2012; Ng & Feldman, 2013a).

We conceptualize *health* as a multifactorial construct that considers aspects of physical, mental, and social wellbeing and as a "[…] concept emphasizing social and personal resources as well as physical capacities" (World Health Organization, 1998, p. 1). As a related concept, health behaviors imply behaviors that are associated with an individual's health status. Typically, a distinction is made between health-impairing and health-protective behaviors (Ogden, 2004). An individual's health is not only influenced by the person's health behaviors but also by other aspects of life, such as genetics, the educational level the person achieved, socioeconomic status, working conditions, and age (Crawford et al., 2016).

Despite an increase in interindividual differences in health parameters with higher age, a general age-related decline in physical and physiological abilities in the musculoskeletal, cardiovascular, sensory, and immune systems is not disputed (Hertel & Zacher, 2015). Along with this, cardiovascular and musculoskeletal diseases and insomnia increase with age (Ng & Feldman, 2013a). Concerning psychological changes, information processing, attention, and memory capabilities are reduced (Crawford et al., 2016). Moreover, slight increases in sickness absence have been observed (Ng & Feldman, 2008), whereas self-rated physical health and somatic complaints have revealed no associations with age (Ng & Feldman, 2013a). Finally, weak positive relationships with general mental health, positive mood, and lower depression and anxiety rates have been observed as well as a slight decrease in health-impairing behaviors (Ng & Feldman, 2013a).

3.2.2 State of Research and Research Questions

Numerous studies have demonstrated associations between psychosocial work characteristics and health, and individual characteristics have been shown to moderate these relationships (e.g., BAuA, 2017; Dragano et al., 2017; Humphrey et al., 2007). Although theoretical lifespan approaches seem to be promising for work design (e.g., Rudolph, 2016), most of the pertinent studies have considered employee age "solely" as a confounding variable, whereas only a few studies have focused on interactions between psychosocial work characteristics and age on health. Most pertinent studies have analyzed the association of one specific work characteristic with health aspects (e.g., job autonomy; see Ng & Feldman, 2015) or without considering employees' age, which obviously prevents the detection of potential age-related patterns.

Two pertinent literature reviews (Truxillo et al., 2012; Zacher & Schmitt, 2016) considered different work characteristics and analyzed their association with age and well-being outcomes. These reviews were narrative with a focus on outcome variables such as job satisfaction, work engagement, strain, and emotional exhaustion (Zacher & Schmitt, 2016).

Moreover, Truxillo et al. (2012) focused on theoretical assumptions with respect to job satisfaction, engagement, and performance rather than providing an integrative research review. However, both reviews concluded that work characteristics interact with employee age in predicting occupational well-being.

We contribute to research and theory on psychosocial work characteristics, age, and health by systematically reviewing and integrating studies on individual health parameters. While doing so, we also included psychosocial work characteristics (e.g., job insecurity, work–life balance, and age diversity among employees) that have become more important in recent years owing to a rapidly changing world of work. To facilitate theoretical and applied conclusions, we rendered the studies that originally used various age group schemas comparable by introducing a schema with consistent age groups. The resulting systematic synthesis of age-sensitive associations of multiple psychosocial work characteristics allowed us to identify age-specific vulnerabilities for poor health. It was our goal to broadly cover psychosocial work characteristics to identify possible areas where an age-sensitive work design may contribute to promoting health across the lifespan.

3.3 Theoretical Approaches and Propositions to Psychosocial Work Characteristics and Aging

Psychosocial work characteristics are important elements of work stress theories, for example, the job demands–resources model (JD-R; Bakker & Demerouti, 2014; Demerouti et al., 2001). Recently, these stress theories have been combined with theoretical approaches on aging and lifespan development, for example, socioemotional selectivity theory (SST; Carstensen, 2006; Carstensen et al., 1999). In the following sections, we develop our theoretical propositions on the basis of these two groups of relevant theoretical approaches and then cluster these propositions with respect to different psychosocial work

characteristics[2].

3.3.1 Demands at Work

Quantitative demands, cognitive demands, work pace, and emotional demands are dimensions of *demands at work* (Pejtersen et al., 2010). To derive propositions within this domain, we drew on cognitive development theories, for example, the theory of fluid and crystallized intelligence (Cattell, 1971), which distinguishes two main categories of intellectual functioning. The fluid intelligence component, which is primarily genetically determined, includes information processing speed, working memory, and reasoning capacities. These are relevant for coping with quantitative and cognitive demands and work pace while the facets of crystallized intelligence primarily depend on experiences and knowledge (Kanfer & Ackerman, 2004). On the basis of observed lifespan trajectories, it has often been postulated that cognitive mechanics (i.e., fluid intelligence) are maximal in the mid-20s, whereas cognitive pragmatics (i.e., crystallized intelligence) grow and then stabilize up to the age of 70 (Baltes et al., 2006). If quantitative demands in the workplace exceed individual supplies and resources, then it is not only intellectual capabilities but also well-being and job stress that are affected (Truxillo et al., 2012; Zacher et al., 2014).

Hypothesis 1a: High quantitative work demands are negatively associated with health parameters. This negative association will be stronger with age when demands mainly draw from fluid intelligence components (e.g., high work pace).

Proposition 1b: High quantitative work demands are negatively associated with health parameters. This negative association will be weaker with age when demands mainly draw from crystallized intelligence components.

[2] Whereas our clustering is based on the domains of the COPSOQ II (Pejtersen et al., 2010), our literature search was not limited to studies employing the COPSOQ II. Moreover, the propositions are restricted to psychosocial work characteristics for which our literature search yielded pertinent studies.

3.3.2 Work Organization and Job Contents

Aspects of *work organization and job contents* entail influence, skill discretion, variation, meaning of work, and commitment to the workplace (Pejtersen et al., 2010). Influence encompasses the constructs of job autonomy or job control, which are central in job stress models such as the JDC (e.g., Karasek, 1979). *Job autonomy* provides employees the independence and freedom to schedule work and determine work procedures (Hackman & Oldham, 1976). It is hence conceptualized as a job resource within the JD-R and is expected to promote work engagement and attitudinal outcomes (Bakker & Demerouti, 2014; Demerouti et al., 2001).

With respect to age, the motivational theory of lifespan development (MTD; Heckhausen et al., 2010) conceptualizes job autonomy as having greater significance for older employees. The theory proposes that an individual's perception of whether they have control over their environment is essential for adaptive development across the lifespan. More specifically, according to the MTD (Heckhausen et al., 2010), primary control processes focus on "[…] changing the world to bring the environment into line with one's wishes. In contrast, secondary control processes are defined as changing the self to bring oneself into line with environmental forces" (p. 35). According to the MTD, individual capacities for primary control decline after midlife. As job autonomy offers compensation for such decreases in the ability to engage in primary control, it becomes more relevant for older employees to influence their job situation according to their wishes.

Proposition 2: Job autonomy is positively associated with health. This association becomes stronger with age.

Not only the effect of job autonomy but also the interactive effect of job autonomy and job demands regarding employee health is of interest because the JDC (Karasek, 1979) predicts high strain for jobs characterized by low autonomy and high demands (*high strain jobs*). The JD-R also hypothesizes that the joint effect of high job demands and low

resources (e.g., low job autonomy) reduces employee health and motivation (see also Demerouti et al., 2001). Whereas the age-contingent reactions to job demands depend on whether they predominantly draw on fluid or crystallized intelligence components (see Proposition 1), we expected clear associations with age regarding job autonomy (Heckhausen et al., 2010; see Proposition 2). Correspondingly, we assumed that older employees would be more vulnerable vis-à-vis high-strain jobs than those in younger age groups on average.

Proposition 3: High strain jobs are associated with impaired health. This relationship becomes stronger with age.

Experienced *meaningfulness* is "[…] the degree to which the individual experiences the job as one which is generally meaningful, valuable, and worthwhile" (Hackman & Oldham, 1976, p. 256). According to the job characteristics model (JCM; Hackman & Oldham, 1976), meaningfulness is determined by task significance, task identity, and skill variety and mediates the positive impact of working conditions on personal and work outcomes. The SST (Carstensen et al., 1999) proposes that the selection and pursuit of social goals change as a function of perceived remaining life perspective. A shorter remaining perspective switches motivational priority – from motives of knowledge acquisition and accumulation at younger ages to emotion-related goals and targets related to meaning when time horizons shrink.

Proposition 4: Meaningful work is positively associated with health parameters. This association becomes stronger with age.

Skill discretion refers to "[…] the level of skill and creativity required on the job and the flexibility permitted to the worker in deciding what skills to employ…" (Karasek et al., 1998, p. 323). Skill variety is closely related to this concept. It indicates the extent "[…] to which a job requires a variety of different activities in carrying out the work …" (Hackman & Oldham, 1976, p. 161). Both aspects are conceptualized as job resources in the

JD-R and are assumed to have positive effects on well-being and work-related behavior (Demerouti et al., 2001). On the other hand, low skill discretion and low skill variety are assumed to have negative effects. They are indicators of *passive jobs* characterized by low demands and low decision latitude within the JDC (Karasek, 1979).

With regard to age, the mental-exercise hypothesis and the principle of differential preservation (Salthouse, 2006) emphasize the protective role of mental activity and complex work environments because they are expected to mitigate the age-dependent decline in cognitive resources with higher age and also to have positive effects on health. In the current research, we conceptualize jobs that are not passive and that allow for high skill discretion or high skill variety as offering *possibilities for development* (cf. Pejtersen et al., 2010). Thus, we expected the following:

Proposition 5: Possibilities for development are positively associated with health parameters. This association becomes stronger with age.

3.3.3 Interpersonal Relations and Leadership

Interpersonal relations and leadership refer to social support from colleagues and supervisors, quality of leadership, social community at work, predictability, recognition, role clarity, and role conflicts (Pejtersen et al., 2010). Different theoretical models such as the JD-R (Demerouti et al., 2001) conceptualize social support from coworkers and supervisors as significant resources for employee well-being. By contrast, no available social support and the presence of interpersonal stressors have been hypothesized to impair health. Regarding age, SST (Carstensen et al., 1999) hypothesizes that the pursuit of knowledge accumulation is more important for younger employees than for those in older age groups. For knowledge accumulation and career success, social support is known to be one key vehicle (Seibert et al., 2001). Also, Scheibe and Zacher (2013) theoretically posited that interpersonal relationships should be especially relevant for younger employees, whereas for older employees, they proposed higher emotion regulation competence and less impairment

from interpersonal stressors.

Proposition 6: Supportive interpersonal relations and leadership are positively associated with employee health. These associations become weaker with age.

3.3.4 Work–Individual Interface

Job insecurity and work–life conflicts are aspects of the *work– individual interface* (Pejtersen et al., 2010). Job insecurity is defined as "perceived powerlessness to maintain desired continuity in a threatened job situation" (Greenhalgh & Rosenblatt, 1984, p. 438) and is considered to be an especially intense source of work stress for an employee who is highly dependent on his or her job (Sverke et al., 2002). This applies in particular to older employees, who typically face more challenges when attempting to find a new job and also often have higher levels of family obligations (Cheng & Chan, 2008).

Proposition 7: Job insecurity is negatively associated with health. This association becomes stronger with age.

Work–life conflicts refer to a lack of balance between work and private life and are defined as "a form of inter-role conflict in which role pressures from the work and family domains are mutually incompatible in some respect" (Greenhaus & Beutell, 1985, p. 77). Consequently, work–life conflicts are not conceptualized as immediate work-related stressors but as induced by high demands or low resources at work (Demerouti et al., 2004). According to the effort-recovery model (Meijman & Mulder, 1998), recovery is crucial for the stressor–strain relation. Because work–life conflicts weaken the chance to recover from strain, they are expected to decrease health and well-being.

Concerning age, Scheibe and Zacher (2013) hypothesized that middle-aged employees experience increased work–life conflicts due to high levels of private and work responsibilities and subsequently higher levels of strain and lower levels of occupational well-being. As emotion regulation competencies also increase with age (Hertel & Zacher, 2015; Scheibe & Carstensen, 2010) and as these competencies facilitate coping with work–

life conflicts, we expected a pronounced vulnerability in middle-aged employees due to the simultaneous presence of high levels of responsibilities and comparatively low levels of coping competencies.

Proposition 8: Work–life conflicts are negatively associated with health. This association is strongest for middle-aged employees.

3.3.5 Values at the Workplace

Justice, mutual trust between employees, trust in management, and social inclusiveness are aspects of *values at the workplace*. Organizational justice is generally defined as people's perceptions of fairness in organizations (Greenberg & Colquitt, 2005). The effort–reward imbalance model (ERI; Siegrist, 1996) is an occupational stress model that specifically focuses on low organizational justice. It proposes that high effort and low reward at work represent a reciprocity deficit, which in turn causes strain. Accordingly, perceptions of low organizational justice and effort– reward imbalance can be viewed as risk factors for stress-related symptoms, poor employee health, and reduced work engagement (Demerouti et al., 2001).

For age as a moderator, individual coping mechanisms are relevant for potential health effects of low perceived justice. Here, SST (Carstensen et al., 1999) states that in later life emotion-related goals, emotion regulation, and positive experiences become more important, whereas negative emotions tend to be avoided and controlled better than in younger years. Furthermore, older individuals more often apply coping mechanism than younger individuals do to realize cognitive and attitude changes and to adjust to circumstances that do not allow for primary control (see also Heckhausen et al., 2010).

Proposition 9: Low organizational justice and effort– reward imbalance are negatively associated with health.

These associations become weaker with age. Factors of social inclusiveness refer to fair and equal treatment related to gender, ethnicity, health, and age (Pejtersen et al., 2010).

In this respect, the social identity approach (Tajfel & Turner, 1979; Turner et al., 1987) states that individuals categorize themselves and others into different social groups (e.g., regarding age [younger or older]) to achieve social belongingness and a sense of self-worth. They identify themselves and similar others as ingroup members and dissimilar others as outgroup members. As for individual consequences of such categorization processes, the relational demography approach (Tsui et al., 1992) proposes that higher (age) diversity increases perceived dissimilarities in working groups, which in turn impairs social integration. Accordingly, younger and older employees perceive themselves as more dissimilar to others at work than middle-aged employees, and they are also expected to be confronted with higher levels of age discrimination. Thus, they are especially negatively affected by age diversity and discrimination at work.

Proposition 10: High age diversity and discrimination at work are negatively associated with health. This association is stronger for younger and older employees and weaker for middle-aged employees.

3.4 Method

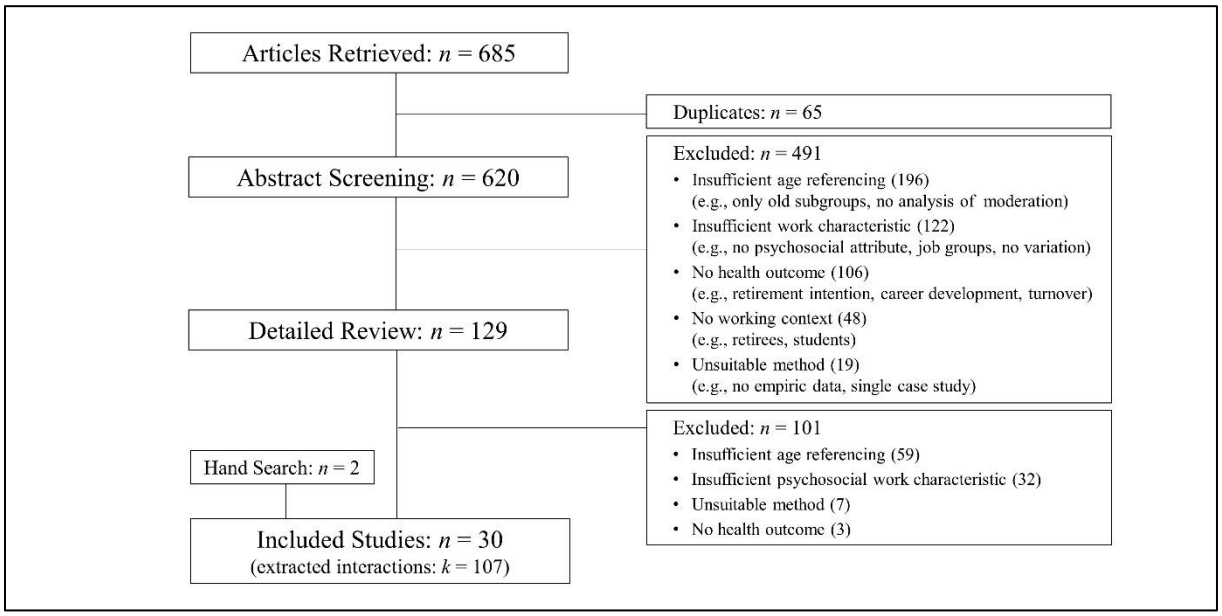
3.4.1 Literature Search

Our review draws from systematic literature searches of the databases PubMed, PsycINFO, PsycARTICLES, and PSYNDEX. We used three main constructs (psychosocial work characteristics, age, and health) and specified these constructs with the following terms: We used *working conditions* and *psychosocial work environment* to specify psychosocial work characteristics, *age differences* or *older workers* to specify age, and *mental health* and *work ability* to specify health (please see the supplementary file for the full search strings). We limited our searches to studies published between 2000 and 2017 because psychosocial work characteristics and aging received particular professional and public interest during this time (cf. Cox et al., 2000; Hertel & Zacher, 2015; Ilmarinen, 2001). Simultaneously, the statutory retirement age in many European countries and labor force participation rates

increased during this time (European Commission, 2017).

Figure 2

Flow chart for the literature search.



3.4.2 Inclusion Criteria

For inclusion, the primary studies needed to be peer-reviewed, published in English or German, and conducted in a work context, that is, articles sampling adolescents, students, or nonworking adults were excluded (see Figure 2 for a flow chart depicting the inclusion/exclusion process). Furthermore, an operationalization of psychosocial work characteristics was necessary (i.e., studies comparing professions instead of tapping into specific work characteristics were not considered). In addition, employees' age needed to have a minimum range of 20 years; that is, studies that focused only on young or only on older employee groups were excluded. Finally, the studies needed to have a suitable study design to answer our research question, that is, all studies were quantitative and empirical; case studies or nonempirical overviews were not considered.

3.4.3 Sample

In accordance with our inclusion and exclusion criteria (Figure 2), we included 28 studies from the literature search. A random sample of 50% of the retrieved articles were double coded for inclusion/exclusion decision by the first author and a trained research assistant. Interrater agreement was nearly perfect (96%). More specifically, the agreement rate for the excluded abstracts was 100%, while the agreement rate for the included articles was 75%. Furthermore, the kappa value of $\kappa = .84$ signifies excellent agreement (Fleiss et al., 2003). The percentages for the different exclusions were as follows: insufficient age referencing (40.4 %), insufficient work characteristic (24.8 %), no health outcome (21.7 %), no working context (10.1 %), and unsuitable method (3 %). Disagreements were resolved by discussion.

Because of their particular relevance for our research topic, two additional articles that we were aware of but that were not retrieved as part of our literature search were added: Shultz et al. (2010) and Zaniboni et al. (2013). Our review thus included 30 studies. Of these studies, 28 (93%) presented at least one significant interaction between psychosocial work characteristics and age, whereas two presented only nonsignificant interactions (see Table 1).

Overall, the samples represented 277,734 employees ($M = 9.258$, $SD = 21.916$) with a mean age of 42.6 years ($SD = 4.5$). A total of 20% of the studies analyzed German samples, 53% other European samples, and 27% samples from countries outside Europe. Most samples consisted of different occupations and stemmed from different economic sectors. In total, 87% had a cross-sectional design, while 13% were longitudinal; 27% of the studies reported results from samples that were representative for the working population.

Table 1

Sample characteristics of the extracted studies

	Reference	Sample size (frequency of analyzed interactions); sector; nation; and average age	Design
1	Andersen et al. (2008)[b]	3.840 (6); various sectors; Denmark, average age: n.a.	cross-sectional
2	Besen et al. (2015)[b]	1.812 (2); various sectors; USA; 41y	cross-sectional
3	Bos et al. (2013)[b]	591 (4); university staff; Netherlands; <35 (17%), 35-44 (28%), 45-54 (32%), ≥55y (23%)	cross-sectional
4	Bosch et al. (2009)[b]	537 (3); airplane manufacturing; Germany; 44.3y	cross-sectional
5	Cheng et al. (2013)[b]	37.329 (10); various sectors; Taiwan; 37.4y (women), 39.4y (men)	cross-sectional
6	Collins & O'Sullivan (2010)[a]	332 (2); various sectors; Ireland; 34.7 y (women), 33.7y (men)	cross-sectional
7	Ervasti et al. (2014)[a]	107. 828 (1); public sector; Finland; 43.4y	cross-sectional
8	Freude et al. (2010)[a]	371 (1); various sectors; Germany; 45.6y	cross-sectional
9	Gellis & Kim (2004)[b]	263 (9); health sector; USA; 39y	cross-sectional
10	Haley et al. (2013)[b]	582 (8); finance (supervisors); South Africa; 18-30 (23%), 31-50 (48%) and 51-65y (29%)	cross-sectional
11	Kivimäki et al. (2008)[a]	3.160 (1); various sectors; Sweden; 19-55 (89%), 56-65y (11%)	longitudinal
12	Kouvonen et al. (2005)[b]	40.851 (10); public sector; Finland; 44.3 years (women) 45.2y (men)	cross-sectional
13	Kraaijeveld et al. (2014)[b]	1.215 (4); computer workers of various sectors; Netherlands; 43y	longitudinal
14	Kuper & Marmot (2003)[a]	9.746 (1); civil service; UK; average age: n.a.	longitudinal
15	Liebermann et al. (2013b)[a]	1.214 (1); various sectors; Germany; 45y	cross-sectional
16	Lindholm et al. (2009)[a]	132 (1); broadcasting; Finland; 42.6 y (women), 45y (men)	cross-sectional
17	Loerbroks et al. (2010)[b]	591 (2); airplane manufacturing; Germany; 17-34 (27%), 35-44 (27%), 45-54 (32%), 55-65y (14%)	cross-sectional
18	Loudoun et al. (2014) [a]	2.640 (2); mine and energy sector; Australia; 46.8y	cross-sectional
19	Mc Carthy et al. (2012)[b]	208 [men] (3); various sectors; Ireland; 54.7y	cross-sectional
20	Moen et al. (2013)[b]	172 (7); university staff; Norway; 43y	cross-sectional
21	Rugulies et al. (2008)[b]	3.727 (2); various sectors; Denmark; 38y	longitudinal
22	Shultz et al. (2010)[a]	15.986 (1); various sectors; 15 Western European countries; 38.9y	cross-sectional
23	Taylor et al. (2013)[a]	1.596 (6); various sectors; Australia; 20-34 (19%), 35-44 (27%), 45-54 (31%), 55-71y (23%)	cross-sectional
24	Tenhiälä et al. (2013)[b]	37.324 (2); public sector; Finland; 46.2y	cross-sectional
25	Tsai et al. (2014)[a]	825 (1); bus drivers; Taiwan; 42y	cross-sectional
26	Weigl et al. (2012)[b]	162 (12); health sector; Germany; 37.2y	cross-sectional
27	Weigl et al. (2013)[a]	173 (1); nursing; Germany; 36.9y	cross-sectional
28	Zaniboni et al. (2013)[b]	117 (2); publishing; Italy; 39y	cross-sectional
29	Conway et al. (2008)[c]	1.754 (1); health care; Italy; >44y (33%)	cross-sectional
30	McGonagle et al. (2015)[c]	2.656 (1); various sectors; USA; 60.8y, 36.6y and 47.7y (subsamples)	cross-sectional

Note. y = years. [a] Study includes exclusively significant interaction results. [b] Study includes significant and nonsignificant interaction results. [c] Study includes exclusively nonsignificant interaction results.

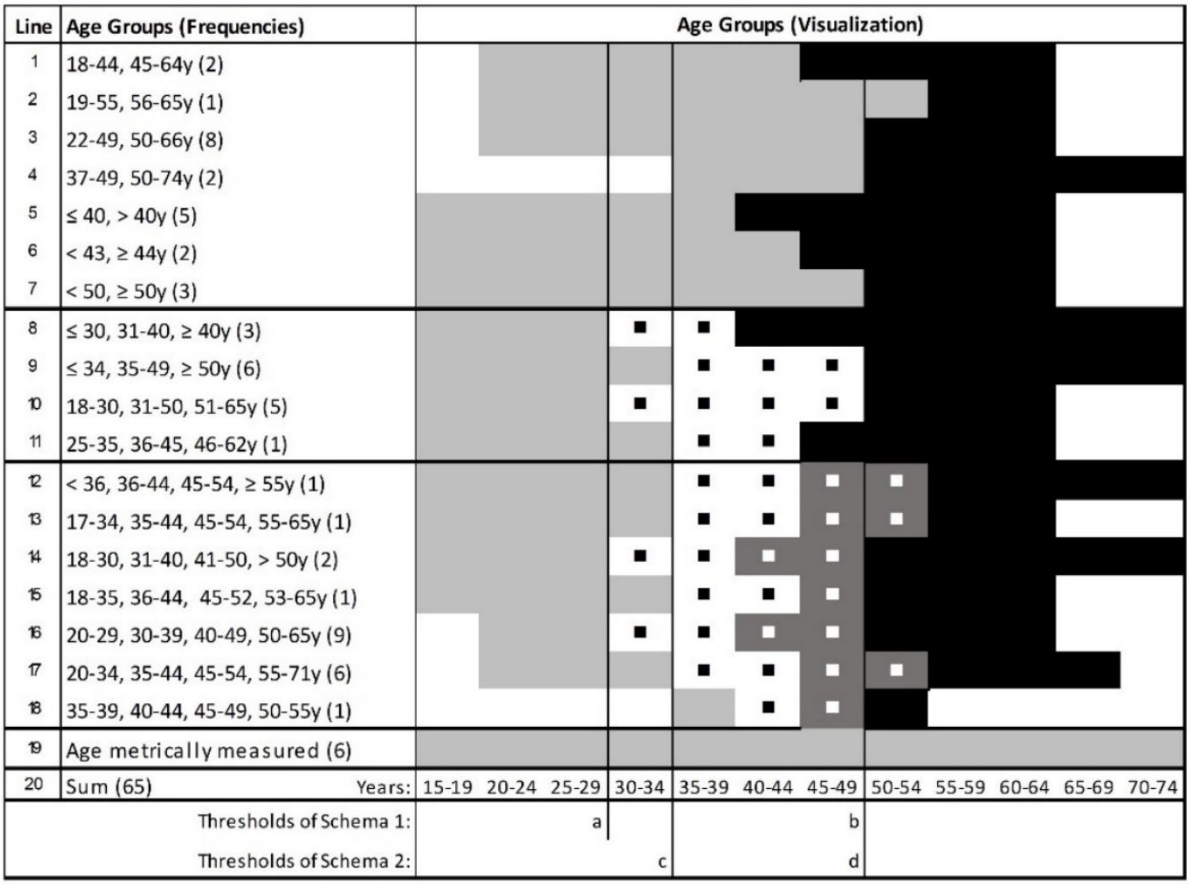
3.4.4 Variable Clusters

In the 30 studies we included, we identified 65 significant and 42 nonsignificant pertinent interactions. We sorted these by five psychosocial work dimensions according to the COPSOQ II (Pejtersen et al., 2010; see Table 2) and introduced a schema of consistent age groups to integrate and compare the significant findings. In the primary studies with significant interactions, we found classifications with two, three, or four age groups and a total of 18 different age-group classifications (see Table 2). For instance, four different classifications used three age groups (see Lines 8– 11 in Figure 3).

To reduce the heterogeneity of age-group classifications across all studies, to achieve comparability in the study results, and to allow for an aggregated assessment of all studies, we aimed to introduce one consistent, homogeneous age-group classification. An important goal of this standardization was to obtain the greatest possible fit (or a minimum deviation) between the new homogeneous classification and the original, heterogeneous age groups used in the primary studies. To achieve this, our approach consisted of three steps.

Figure 3

Distribution of age group classifications for the extracted significant interactions.



Note. Each line indicates a specific age group classification used in at least one primary study. Colors represent different age groups and their range. Schema 1 with the age thresholds a and b (and the resulting age groups of ≤29, 30–49, ≥50 years) was compared with Schema 2 (with the thresholds c and d) to form consistent age groups for this review.

First, we made a decision about the desired number of age groups and chose three groups. Three groups allow authors to differentiate younger not only from older but also from middle-aged employees, while the number of groups is still limited. Hence, we attained a classification that was as simple as possible but as differentiated as necessary. Second, we checked whether we could continue using an age group that was already very frequently represented in the included studies. Because 62% of all the interactions included an age

group of 50 years and older (see Figure 3), we decided to also use this age group. Third, the last age threshold (i.e., to differentiate between young and middle-aged groups) had to be determined. To do so, we aimed to apply the age group schema with the "best fit" (or preferably the lowest deviation) to the original age groups from the primary studies.

To calculate this best fit between the newly formed age groups and the original groups from the primary studies, we compared the total deviations of two different age group schemas from the age groups used in the primary studies (for details, see Figure 3): Schema 1 applied the age groups ≤ 29, 30–49, and ≥ 50 (see the thresholds identified as "a" and "b" in Figure 3). For instance, two misclassifications would have occurred for a specific study if this schema were used, as shown in Line 11 of Figure 3: The original age group 36–44 would be transferred to the newly formed 30–49-year-old group, and employees in both the 30–35 and 45–49-year-old groups would be misclassified into this new group (resulting in a deviation score of 2). In the same way, we calculated the deviation scores for all 18 different age classifications used in the primary studies (see Figure 3) and added them to obtain the deviation total.

We then compared the calculated deviation for Schema 1 (≤ 29, 30–49, and ≥ 50) versus Schema 2 (≤ 34, 35–49, and ≥ 50). Schema 2 had less deviation from the original age groups used in the primary studies (44 vs. 62 deviations) and was therefore applied in our study. This trichotomy of young (≤ 34 years), middle-aged (35 –49 years), and older employees (≥ 50 years) is also in line with existing age gradings in working life (Kohli, 2007; Rudolph, 2016), and six significant interactions from the studies also classified employees using these three age groups (see Line 9 in Figure 3).

Table 2

Interactions in the extracted studies

Domain	Psychosocial work characteristic	sig. interactions	nonsig. interactions	number of cases
Demands at work	Quantitative and cognitive demands	7 (44%)	9 (56%)	16 (100%)
	Emotional demands	0 (0%)	1 (100%)	1 (100%)
Work organization and job contents	Job autonomy	12 (67%)	6 (33%)	18 (100%)
	High strain	10 (63%)	6 (37%)	16 (100%)
	Meaning of work	1 (100%)	0 (0%)	1 (100%)
	Possibilities for development	6 (67%)	3 (33%)	9 (100%)
Interpersonal relations and leadership	Social support, quality of leadership, recognition	13 (72%)	5 (28%)	18 (100%)
	Predictability	0 (0%)	2 (100%)	2 (100%)
	Role clarity	0 (0%)	1 (100%)	1 (100%)
Work-individual interface	Job insecurity	7 (78%)	2 (22%)	9 (100%)
	Work-life conflict	1 (50%)	1 (50%)	2 (100%)
Values at the workplace	Justice	6 (50%)	6 (50%)	12 (100%)
	Social inclusiveness	2 (100%)	0 (0%)	2 (100%)
Sum		65 (61%)	42 (39%)	107 (100%)

To detect general patterns in the relationships between psychosocial work characteristics, age, and poor health, we determined for each finding which age group had been (especially) susceptible to poor health (i.e., young, middle-aged, or older employees). We thus identified the vulnerability of a particular age group according to the age classification of a respective primary study and transferred this vulnerability to the respective age group in our consistent age group schema (see the last columns in Table 3 until Table 7 for details).

In addition to the classification of psychosocial work characteristics and age, we also clustered the health parameters. In accordance with Ng and Feldman's (2013a) meta-analysis, we clustered health-related outcome variables into general health (24.5% of all interactions), physical health (24.5 %), mental health (40%), and health-behavior facets (11%).

3.5 Results

3.5.1 Identified Psychosocial Work Characteristics

We first assigned the overall 107 interactions to 10 work characteristics (see Table 2). By doing so, we identified 17% of the interactions as operationalizing *autonomy* and *interpersonal relations and leadership* each, followed by *demands at work* (15 %), *high strain* (high demands and low job control; 15 %), *justice* (11 %), *possibilities for development* (8 %), *job insecurity* (8 %), *work–life conflict* (2 %), *social inclusiveness* (2 %), and *meaning of work* (1 %). Three additional characteristics (accounting for a total of 4%) were found in our literature search: emotional demands, predictability, and role clarity. For these characteristics, all interactions were statistically insignificant. Overall, 65 associations (61%) were statistically significant interactions, whereas 42 (39%) of these associations were not (see Table 2).

3.5.2 Age-Related Vulnerabilities Depending on Psychosocial Work Characteristics

The significant interactions are displayed in Table 3 until Table 7 clustered by five domains of psychosocial work characteristics and supplemented by the vulnerabilities that were identified for the consistent age groups (≤ 34, 35 – 49, and ≥ 50, see the last columns in the tables). To assess the overall health risk implied by each psychosocial work characteristic per age group, we first analyzed the frequencies of the vulnerabilities for young, middle-aged, and older employees. Second, we compared these frequencies with the total number of interactions for the related work characteristic (see Table 8). According to this approach, work–life conflicts, (a lack of) social inclusiveness, quantitative work demands, and high strain jobs were especially critical characteristics for the health of the youngest age group (for details, see Table 8). For the middle-aged group, meaningfulness, possibilities for development, interpersonal relations and leadership, quantitative work demands, job autonomy, and organizational justice were particularly relevant factors. Finally, for older employees, (a lack of) social inclusiveness, job autonomy, interpersonal

relations, and leadership were especially critical characteristics for health (see Table 8).

3.5.3 Age-Related Vulnerabilities and Clusters of Health Variables

Besides the analyses of vulnerabilities for psychosocial work characteristics per age group, we also differentiated between clusters of health variables. In the youngest age group, we observed the highest risk for mental health (52 %), followed by physical health (26 %), and general health (22%), and no risk for health-impairing behavior. For the middle-aged group, we observed a similar pattern. However, the oldest age group showed a more evenly distributed pattern for general health (33 %), mental health (30 %), physical health (23 %), and poor health behavior (13 %).

3.5.4 Types of Interactions

We also focused on whether the associations of psychosocial work characteristics and health would differ across different age groups. Thus, we analyzed the results of the primary studies regarding the specific types of observed interactions (i.e., the directions of the associations for the different age groups), and we did not observe any *crossover* (or disordinal) interactions (i.e., no contradictory directions of associations across the different age groups). However, we observed two types of *noncrossover* (or ordinal) interactions. In about two thirds of the significant interactions (k = 43), an association was found for one group (e.g., young employees), whereas the association was not found for another group (e.g., older employees). For the remaining significant interactions (k = 22), we found different strengths of associations across age groups (e.g., a weaker but statistically significant association for younger and a stronger association for older employees). In the following sections, we describe the results per domain in detail and how they accord with our propositions.

3.5.5 Demands at Work

For seven of 16 interactions involving the associations between high quantitative job demands and age we reported significant findings (Table 3). The study by Haley et al.,

(2013), which investigated high fluid components of work demands (e.g., continuous attention), identified only older employees as vulnerable to mental health problems. This result is in line with Proposition 1a. Interactions addressing demands that mainly drew from crystallized components identified younger and middle-aged employees as vulnerable (thereby confirming Proposition 1b; Gellis & Kim, 2004). However, studies that did not differentiate between these components but instead combined the fluid and crystallized components in their analyses, for instance, via high workload (Cheng et al., 2013; Haley et al., 2013; Kraaijeveld et al., 2014), did not show a clear age-related pattern.

Table 3

Demands at work x age interactions

No.	Reference	Dimension[a]	Work characteristic	Age groups (study)	Health parameter	Findings[b]	Age groups (in years)[c]		
							≤34	35-49	≥50
1	Cheng et al. (2013)	Quantitative Demands	High job demands	20-29, 30-39, 40-49, 50-65y	General health (self-rated health)	For female employees under 40, high psychological job demands (e.g., fast work) are associated with poor health. For older female and all male employees, there is no association.	x		
2	Gellis & Kim (2004)	Quantitative Demands	High job pressure	22-49, 50-66y	Mental health (depressive mood)	Job pressure (e.g., dealing with crisis) is associated with depressive mood in younger but not in older employees.	x	x	
3	Gellis & Kim (2004)	Quantitative Demands	High job pressure	22-49, 50-66y	Mental health (job stress)	Job pressure (i.e., dealing with crises) was associated with job stress for younger but not for older employees.	x	x	
4	Haley et al. (2013)	Quantitative Demands	High job pressure	18-30, 31-50, 51-65y	Mental health (emot. exhaustion)	High job pressure (i.e., too much work to do) was associated with exhaustion in the young and middle age group not in older employees.	x	x	
5	Cheng et al. (2013)	Quantitative Demands	High job demands	20-29, 30-39, 40-49, 50-65y	Mental health (Burnout)	High psychological job demands (e.g., fast work, excessive work) were associated with a higher burnout score, especially for the two middle age groups.		x	
6	Haley et al. (2013)	Quantitative / cognitive Demands	High mental load	18-30, 31-50, 51-65y	Mental health (emot. exhaustion)	A high level of mental load (e.g., continuous attention to work) was associated with exhaustion in older but not in the younger and middle age group.			x
7	Kraaijeveld et al. (2014)	Quantitative Demands	High work pace and load	<43, ≥44y	General health (need for recovery)	Job demands (work pace and load) were associated with a subsequent need for recovery, especially for older employees.			x

Note. y = years; x = this age group was indicated as being (especially) vulnerable to the respective psychosocial work characteristic. [a] = The designation of the dimensions was based on the COPSOQ (Pejtersen et al., 2010). [b] = Findings refer to the original age group from the primary study. [c] = These age groups were consistently formed across all extracted interactions to render the studies comparable.

Table 4

Work organization and job contents x age interactions

No.	Reference	Dimension[a]	Work characteristic	Age groups (study)	Health parameter	Findings[b]	Age groups (in years)[c] ≤34	35-49	≥50
8	Cheng et al. (2013)	Influence	Low job autonomy	20-29, 30-39, 40-49, 50-65y	Mental health (Burnout)	In the male subgroup, for employees younger than 40 years of age, low job control was associated with burnout. For older employees, there was no association.	x		
9	Loudoun et al. (2014)	Influence	Low job autonomy	<50, ≥50y	Physical health (sleep disturbance)	Low latitude over work tasks was associated with sleeping disorders for younger employees but not for older employees.	x	x	
10	Besen et al. (2015)	Influence	Low job autonomy	Metric	Mental health	Job control was associated with better mental health, especially for younger employees.	x	x	
11	Lindholm et al. (2009)	Influence	Low job autonomy	25-35, 36-45, 46-62y	Physical health (cardiovasc. health)	Job control was associated with better cardiovascular recovery after work for middle aged but not for younger and older employees.		x	
12	Shultz et al. (2010)	Influence	Low job autonomy	<39, ≥ 40y	Mental health (job stress)	Control was associated with low work stress when confronted with high demands, especially for older employees.		x	x
13	Weigl et al. (2013)	Influence	Low job autonomy	Metric	General health (work-ability)	Work ability decreased with age for employees with low control. For employees with high control, there was no association between age and work ability.		x	x
14	Cheng et al. (2013)	Influence	Low job autonomy	20-29, 30-39, 40-49, 50-65y	Mental health (Burnout)	In the female subgroup, only for employees between 30 and 40 and older than 50 years of age, low job control was associated with burnout.		x	x
15	Andersen et al. (2008)	Influence	Low job autonomy	18-44, 45-64y	Health-related behavior (smoking)	Low influence was associated with smoking behavior, especially for older employees.			x

16	Cheng et al. (2013)	Influence	Low job autonomy	20-29, 30-39, 40-49, 50-65y	General health (self-rated health)	Low job control was associated with poor self-rated health in the oldest male subgroup. For female employees, there was no association.		x
17	Haley et al. (2013)	Influence	Low autonomy (decision making)	18-30, 31-50, 51-65y	Mental health (emot. exhaustion)	A low level of participation in decision making was associated with exhaustion in the older but not in the younger and middle age group.		x
18	Loudoun et al. (2014)	Influence	Low autonomy (shift scheduling)	<50, ≥50y	Physical health (sleep disturbance)	Low control over shift scheduling was associated with sleeping disorders for older but not for younger employees.		x
19	Mc Carthy et al. (2012)	Influence	Low job autonomy	37-49, 50-74y	Physical health (cardiovasc. health)	Low job control was associated with the incidence of a heart event for older but not for younger employees.		x
20	Moen et al., 2013	Influence	High strain (low job autonomy, high demands)	≤40, >40y	General health (pseudoneurological symptoms)	High strain was positively associated with pseudoneurological symptoms in the younger age group but not in the older age group.	x	
21	Moen et al., 2013	Influence	High strain	≤40, >40y	Physical health (musculoskeletal symptoms)	In the female subgroup, high strain was positively associated with musculoskeletal symptoms. However, for older women, there was no association.	x	
22	Moen et al., 2013	Influence	High strain	≤40, >40y	Physical health (allergic symptoms)	In the male subgroup, high strain was positively associated with allergic symptoms. For older men, there was no association.	x	
23	Tsai et al. (2014)	Influence	High strain	≤34, 35-49, ≥50y	Physical health (cardiovasc. health)	High strain was associated with a risk of inflammatory diseases for the youngest age group. For all other age groups, there was no such relation.	x	

24	Kivimäki et al. (2008)	Influence	High strain	19-55, 56-65y	Physical health (cardiovasc. health)	High strain was associated with the incidence of ischemic disease for younger employees but not for older ones.	x	x	
25	Kuper & Marmot (2003)	Influence	High strain	35-39, 40-44, 45-49, 50-55y	Physical health (cardiovasc. health)	High strain was associated with the incidence of coronary heart disease. This effect was strongest in the youngest age group. No association was found for the 40-45 year-old employees.		x	
26	Moen et al., 2013	Influence	High strain	≤40, >40y	Physical health (gastrointestinal symptoms)	High strain was positively associated with gastrointestinal symptoms in the older age group but not in the younger one.		x	x
27	Kraaijeveld et al. (2014)	Influence	High strain	<43, ≥44y	General health (need for recovery)	High-strain jobs (low control/high demands) were associated with a later need for recovery, especially for older employees.			x
28	Mc Carthy et al. (2012)	Influence	High strain	37-49, 50-74y	Physical health (cardiovasc. health)	High strain was associated with the incidence of a heart event for older but not for younger employees.			x
29	Andersen et al. (2008)	Influence	High strain	18-44, 45-64y	Health-related behavior (smoking)	High strain was associated with smoking behavior, especially for older employees.			x
30	Taylor et al. (2013)	Meaning of work	Low meaning of work	20-34, 35-44, 45-54, 55-71y	Mental health (psychological well-being)	Meaning of work was positively associated with psychological well-being. This relation increased up to age 54 and was weakest for the oldest group.		x	
31	Zaniboni et al. (2013)	Possibilities for development	High task variety	Metric	Mental health (Burnout)	Task variety was associated with a lower risk of burnout, especially for younger employees.	x	x	

32	Bos et al. (2013)	Possibilities for development	High task variety	<36, 36-44, 45-54, ≥55y	General health (need for recovery)	Task variety and need for recovery were not associated. For the 45-54 year-old employees, a positive association was found.		x
33	Kouvonen et al. (2005)	Possibilities for development	Passive jobs	18-34, 35-50, 51-64y	Health-related behavior (heavy drinking)	Strain was not associated with heavy drinking (low/high strain, passive/active jobs). However, for middle-aged women, passive jobs (low control/low demands) were related to heavy drinking.	x	
34	Kouvonen et al. (2005)	Possibilities for development	Low effort	18-34, 35-50, 51-64y	Health-related behavior (heavy drinking)	Low effort was associated with heavy drinking for the middle and the oldest age groups (vs. high effort). For younger employees, there was no relation.	x	x
35	Kouvonen et al. (2005)	Possibilities for development	Low demands	18-34, 35-50, 51-64y	Health-related behavior (heavy drinking)	For women, job demands were not associated with heavy drinking. However, in the middle-aged and oldest age groups, low demands were related to a higher risk (vs. intermediate/high demands).	x	x
36	Weigl et al. (2012)	Possibilities for development	Low skill discretion	≤30, 31-40, ≥40y	General health (work-ability)	Learning opportunities were associated with higher work ability for older employees. There was no association for the other age groups.	x	x

Note. y = years; x = this age group was indicated as being (especially) vulnerable to the respective psychosocial work characteristic. [a] = The designation of the dimensions was based on the COPSOQ (Pejtersen et al., 2010). [b] = Findings refer to the original age group from the primary study. [c] = These age groups were consistently formed across all extracted interactions to render the studies comparable.

Table 5

Interpersonal relations and leadership x age interactions

No.	Reference	Dimension[a]	Work characteristic	Age groups (study)	Health parameter	Findings[b]	Age groups (in years)[c] ≤34	35-49	≥50
37	Taylor et al. (2013)	Recognition	Low respect	20-34, 35-44, 45-54, 55-71y	Mental health (psychological well-being)	Respect was positively associated with psychological well-being, especially for the youngest age group.	x		
38	Taylor et al. (2013)	Social Support	Low organiz. support	20-34, 35-44, 45-54, 55-71y	Mental health (psychological well-being)	Organizational support was positively associated with psychological well-being. This relation was strongest for the youngest group and weakest for the oldest.	x		
39	Gellis & Kim (2004)	Quality of Leadership	Low satisfaction with supervisor	22-49, 50-66y	Mental health (job stress)	Low satisfaction with the supervisor was associated with job stress for younger but not for older employees.	x	x	
40	Gellis & Kim (2004)	Social Community at Work	Low satisfaction with communication	22-49, 50-66y	Mental health (job stress)	Low satisfaction with communication within the organization was associated with job stress, especially in younger employees.	x	x	
41	Gellis & Kim (2004)	Social support	Low organiz. support	22-49, 50-66y	Mental health (depressive mood)	Low organizational support was associated with depressive moods for younger but not for older employees.	x	x	
42	Gellis & Kim (2004)	Social support	Low organiz. support	22-49, 50-66y	Mental health (job stress)	Low organizational support was associated with job stress for younger employees but not for older ones.	x	x	
43	Taylor et al. (2013)	Quality of Leadership	Low supervisor consultation	20-34, 35-44, 45-54, 55-71y	Mental health (psychological well-being)	Supervisor consultation was positively associated with psychological well-being. This effect was weakest for the youngest and oldest age groups and strongest for the two age groups in the middle.		x	

44	Kouvonen et al. (2005)	Recognition	Low rewards	18-34, 35-50, 51-64y	Health-related behavior (heavy drinking)	Rewards were not associated with heavy drinking. However for middle-aged men, low rewards were related to heavy drinking (vs. high rewards).	x	
45	Haley et al. (2013)	Quality of Leadership	Low supervisor support	18-30, 31-50, 51-65y	Mental health (emot. exhaustion)	Low supervisor support was associated with exhaustion in the middle-aged and older groups but not in younger employees.	x	x
46	Freude et al. (2010)	Recognition	Low rewards	metric	Physical health (vitality)	Vitality decreased as age increased. Occupational rewards reduced this relation.	x	x
47	Weigl et al. (2012)	Social Community at Work	Poor social climate	≤30, 31-40, ≥40y	General health (work ability)	A good social climate was associated with higher work ability for older employees. There was no association for the other age groups.	x	x
48	Bosch et al. (2009)	Social support	Low social support	Metric	Physical health (immunological)	Low social support from colleagues and supervisors was associated with immunodeficiency, especially for older employees.	x	x
49	Gellis & Kim (2004)	Social Community at Work	Low satisfaction with co-workers	22-49, 50-66y	Mental health (job stress)	Low satisfaction with co-workers was associated with job stress for older but not for younger employees.		x

Note. y = years; x = this age group was indicated as being (especially) vulnerable for the respective psychosocial work characteristic. [a] = The designation of the dimensions was based on the COPSOQ (Pejtersen et al., 2010). [b] = Findings refer to the original age group from the primary study. [c] = These age groups were consistently formed across all extracted interactions to render the studies comparable.

Table 6

Work individual interface x age interactions

No.	Reference	Dimension[a]	Work characteristic	Age groups (study)	Health parameter	Findings[b]	Age groups (in years)[c]		
							≤34	35-49	≥50
50	Collins & O'Sullivan, 2010	Job Insecurity	Job insecurity	18-30, 31-40, 41-50, >50y	Physical health (musculoskeletal symptoms)	For female employees, job insecurity was positively related to musculoskeletal symptoms only in the youngest age group.	x		
51	Rugulies et al. (2008)	Job Insecurity	Job insecurity	<50, ≥50y	General health (self-rated health)	Women with job insecurity had an increased risk of a decline in health at follow-up. The effect was stronger for younger employees.	x	x	
52	Collins & O'Sullivan, 2010	Job Insecurity	Job insecurity	18-30, 31-40, 41-50, >50y	Physical health (musculoskeletal symptoms)	For male employees, job insecurity was positively related to musculoskeletal symptoms only in the youngest and the oldest age groups.	x		x
53	Cheng et al. (2013)	Job Insecurity	Job insecurity	20-29, 30-39, 40-49, 50-65y	General health (self-rated health)	Job insecurity was associated with poor health in the two middle age groups for men. For the other age groups, there was no association.		x	
54	Taylor et al. (2013)	Job Insecurity	Job insecurity	20-34, 35-44, 45-54, 55-71y	Mental health (psychological well-being)	Job insecurity was negatively associated with psychological well-being. The strongest effect was found in the group of 35-54 year-old employees, the weakest in the youngest age group.		x	
55	Cheng et al. (2013)	Job Insecurity	Job insecurity	20-29, 30-39, 40-49, 50-65y	General health (self-rated health)	Job insecurity was associated with poor self-rated health in the oldest age group for women. For younger employees, there was no association.			x
56	Ervasti et al. (2014)	Job Insecurity	Temporary employment	18-35, 36-44, 45-52, 53-65y	Mental health (depression/	Temporary employment was associated with longer disability episodes caused by			x

					depressive mood)	depression, compared with permanent employment. This relation was pronounced in the oldest age group.	
57	Weigl et al. (2012)	Work-life Conflict	Work-life conflict	≤30, 31-40, ≥40y	General health (work-ability)	Work-life conflict was associated with a decrease in work ability for young and middle-aged employees. For older ones, there was no association.	x

Note. y = years; x = this age group was indicated as being (especially) vulnerable to the respective psychosocial work characteristic. [a] = The designation of the dimensions was based on the COPSOQ (Pejtersen et al., 2010). [b] = Findings refer to the original age group from the primary study. [c] = These age groups were consistently formed across all extracted interactions to render the studies comparable.

Table 7

Values at the workplace x age interactions

No.	Reference	Dimension[a]	Work characteristic	Age groups (study)	Health parameter	Findings[b]	Age groups (in years)[c] ≤34	35-49	≥50
58	Cheng et al. (2013)	Organizational Justice	Low justice	20-29, 30-39, 40-49, 50-65y	General health (self-rated health)	Low workplace justice was associated with poor health, especially for younger employees.	x		
59	Cheng et al. (2013)	Organizational Justice	Low justice	20-29, 30-39, 40-49, 50-65y	Mental health (Burnout)	Low workplace justice was associated with high burnout, especially for younger employees.	x		
60	Tenhiälä et al. (2013)	Organizational justice	Low organizational justice	metric	General health (spells of absence)	Organizational justice was associated with fewer episodes of sickness longer than three days. In older age groups, this relation became stronger.		x	x
61	Gellis & Kim (2004)	Organizational Justice	Low satisfaction with fair pay	22-49, 50-66	Mental health (job stress)	Less satisfaction with fair pay was associated with job stress in older employees but not in younger ones.			x
62	Kouvonen et al. (2005)	Organizational Justice (ERI)	Low job stress (ERI)	18-34, 35-50, 51-64y	Health-related behavior (heavy drinking)	In all age groups, low, intermediate, and high effort-reward imbalances (job stress) were not associated with heavy drinking. For middle-aged women, intermediate job stress (compared with low job stress) was associated with a lower risk for heavy drinking.		x	
63	Loerbroks et al. (2010)	Organizational Justice (ERI)	Job stress (ERI)	17-34, 35-44, 45-54, 55-65y	Physical health (cardiovasc. health)	Effort-reward imbalance was associated with low heart rate variability for 35-44 year-old employees. For younger and older employees, there was no association.		x	
64	Taylor et al. (2013)	Social Inclusiveness	Discrimination at work	20-34, 35-44, 45-54, 55-71y	Mental health (psychological well-being)	Everyday discrimination was negatively associated with psychological well-being. This effect was strongest for the youngest and oldest employees.	x		x

65	Liebermann et al. (2013b)	Social inclusiveness	High age diversity	<30 , 30-50, >50y	General health (self-rated health)	Age diversity in teams was associated with poorer health for younger and older employees but not for middle-aged ones.	x	x

Note. y = years; x = this age group was indicated as being (especially) vulnerable to the respective psychosocial work characteristic. [a] = The designation of the dimensions was based on the COPSOQ (Pejtersen et al., 2010). [b] = Findings refer to the original age group from the primary study. [c] = These age groups were consistently formed across all extracted interactions to render the studies comparable.

Table 8

Vulnerabilities to psychosocial work characteristics across age groups

	High quantitative work demands	Job autonomy	High strain	Meaning-fulness	Possibilities for development	Interpers. relations, leadership	Job insecurity	Work-life conflict	Org. justice	Social Inclu-siveness	Number of cases
≤34 years	57% (4)	25% (3)	50% (5)	0% (0)	17% (1)	46% (6)	43% (3)	100% (1)	33% (2)	100% (2)	29% (27)
35-49 years	57% (4)	50% (6)	30% (3)	100% (1)	83% (5)	77% (10)	43% (3)	0% (0)	50% (3)	0% (0)	38% (35)
≥50 years	29% (2)	67% (8)	40% (4)	0% (0)	67% (4)	39% (5)	43% (3)	0% (0)	33% (2)	100% (2)	33% (30)
Interactions	*100% (7)*	*100% (12)*	*100% (10)*	*100% (1)*	*100% (6)*	*100% (13)*	*100% (7)*	*100% (1)*	*100% (6)*	*100% (2)*	*100% (92)*

Note: Boldface: Values ≥ 50%, i.e., for more than 50% of the extracted interactions involving this work characteristic, the age group in question was identified as (especially) vulnerable. The absolute numbers of significant interactions are given in parentheses.

3.5.6 Work Organization and Job Contents

Job Autonomy. Twelve of 18 interactions that focused on job autonomy were significant (Table 4). Only one interaction revealed that young employees were vulnerable to mental health problems (Cheng et al., 2013). The other results showed vulnerabilities for middle-aged employees and, to a greater extent, for older employees in terms of poor general health (Cheng et al., 2013; Weigl et al., 2013), physical health (Lindholm et al., 2009; Loudoun et al., 2014; Mc Carthy et al., 2012), mental health (Besen et al., 2015; Cheng et al., 2013; Haley et al., 2013; Shultz et al., 2010), and health behavior (Andersen et al., 2008). These results thus mostly confirmed Proposition 2.

High Strain. Ten of 16 interactions involving high-strain jobs were significant (Table 4). These interactions showed that primarily young employees were negatively affected in terms of physical health (Kivimäki et al., 2008; Moen et al., 2013; Tsai et al., 2014) and general health (Moen et al., 2013). Fewer studies identified the oldest and middle-aged employees as vulnerable to problems with their physical health (Kuper & Marmot, 2003; McCarthy et al., 2012; Moen et al, 2013), general health (Kraaijeveld et al., 2014), and health behavior (Andersen et al., 2008; see Table 8). Hence, Proposition 3 was mostly not confirmed.

Meaning of Work. The only study focusing on meaningful work identified a significant interaction. This study by Taylor et al. (2013) revealed a positive association with psychological well-being, which increased steadily up to middle age and dropped to its lowest value for older employees. This result pattern confirmed Proposition 4 only in part because we proposed that it would increase continuously with age.

Possibilities for Development. Six of nine interactions involving possibilities for development were significant, and the particular pattern of results confirmed Proposition 5 in part because possibilities for development showed the lowest relevance for young employees' health compared with middle-aged and older employees (see Table 8). The one

study that identified young employees as especially at risk investigated mental health (Zaniboni et al., 2013). All remaining interactions revealed vulnerabilities for employees older than 34 years of age in terms of health behavior (Kouvonen et al., 2005) and general health (Bos et al., 2013; Weigl et al., 2012).

Interpersonal Relations and Leadership. Thirteen of 18 interactions involving work characteristics regarding interpersonal relations and leadership showed significant interactions (Table 5), indicating the highest overall level of vulnerability regarding poor health for middle-aged employees and the lowest for older employees, thereby partly confirming Proposition 6 (see Table 8). Specifically, low social support was associated with poor mental (Gellis & Kim, 2004; Taylor et al., 2013) and physical health (Bosch et al., 2009) especially among middle-aged and younger employees. Regarding the impact of a poor social community at work, we observed a higher level of vulnerability for middle-aged and older age groups in terms of mental health (Gellis & Kim, 2004) and general health (Weigl et al., 2012). The negative impact of poor recognition was especially pronounced for the middle-aged group with respect to poor health behavior (Kouvonen et al., 2005) and for older employees regarding physical health (Freude et al., 2010). Poor leadership quality had previously been examined only with respect to mental health effects, with particularly negative repercussions for the middle-aged group (Gellis & Kim, 2004; Haley et al., 2013; Taylor et al., 2013).

3.5.7 Work–Individual Interface

Job Insecurity. Seven of nine interactions focusing on job insecurity revealed significant findings. However, they did not identify one specific age group as especially vulnerable for this work characteristics (see Table 6), thereby mostly not confirming Proposition 7. The results indicated that younger employees were vulnerable in terms of physical (Collins & O'Sullivan, 2010) and general health (Rugulies et al., 2008) when experiencing job insecurity, whereas middle-aged employees were shown to be at risk for

mental health (Taylor et al., 2013) and general health problems (Cheng et al., 2013; Rugulies et al., 2008). In the older subgroup, associations were pronounced for mental (Ervasti et al., 2014), general (Cheng et al., 2013), and physical health (Collins & O'Sullivan, 2010).

Work–Life Conflict. One of two studies demonstrated a significant moderating effect of age on the relationship between work–life conflicts and health: Weigl et al. (2012) found that work– life conflicts were associated with a decrease in work ability for young employees. Thus, Proposition 8 was not confirmed because we expected a specific vulnerability for the middle-aged group.

3.5.8 Values at work

Organizational Justice. Six of 12 interactions involving organizational justice were significant (Table 7). For middle-aged employees, organizational justice was especially relevant for general health (Tenhiälä et al., 2013), physical health (Loerbroks et al., 2010), and health behavior (Kouvonen et al., 2005). As our findings did not reveal the expected continuous decrease in its relevance with age, Proposition 10 was not confirmed.

Social Inclusiveness. Two interactions investigating social inclusiveness were significant, and both identified the youngest and the oldest employees as especially vulnerable to poor health, which fully confirmed Proposition 10. Age diversity in teams was associated with poorer individual health only for younger and older age groups (Liebermann et al., 2013b). Also, discrimination was related to poor psychological well-being for these age groups (Taylor et al., 2013).

3.6 Discussion

Our review focused on how psychosocial work characteristics interact with chronological age with regard to employee health. We explored whether there were interactions and which age groups were especially vulnerable vis-à-vis different characteristics (for a summary, see Table 8). Concerning our results, we first found that many of our propositions were at least partly confirmed. Second, we did not find

contradictory associations between psychosocial work characteristics and health for different age groups (i.e., the associations varied as a matter of degree), thus illustrating the importance of occupational health promotion in general and the potential for age-sensitive work design in particular. Third, our analyses revealed middle-aged employees as especially vulnerable overall (Table 8), but these aggregated effects did not exhibit a clear pattern.

Next, we critically evaluate our findings and outline suggestions for future research and practice. In doing so, we consider the potential impact of the healthy worker effect (HWE). The HWE stresses the necessity of maintaining a good health status for staying employed across the lifespan. Morbidity and mortality rates in working populations can be underestimated because only healthy older employees tend to remain in their jobs (Li & Sung, 1999; McMichael, 1976). In terms of our research question, the HWE would be able to account for better observed health in older than in younger age groups, which may prevent a clear distinction between actual age and selection effects: It is unclear whether older employees are healthier owing to their lower vulnerability vis-avis certain work characteristics, to a selection process that excludes older unhealthy individuals from the workforce (i.e., the healthy [survivor] effect), or to a sampling selection bias (e.g., older employees participated in the study because of better health; Baltes et al., 1999). Thus, there is the danger of overestimating the health risks for younger employees and underestimating the health risks for older age groups. This constellation applies to a minority of our propositions. In the following, we make concrete suggestions about how to interpret our results in light of a possible HWE.

3.6.1 Summary and Interpretation of the Findings

Findings regarding *high quantitative work demands* suggest that effects of age on health depend on the type of demands, especially whether they draw on fluid information processing or on knowledge and experience. However, half of the findings were nonsignificant interactions, which obviously represents only partial support for our

proposition. This lack of support may reflect either a weaker or a more variable effect than expected or it might reflect an HWE. Specifically, concerning crystallized intelligence components, Proposition 1b, which was supported, might also be affected by the HWE: Older employees with a less pronounced crystallized intelligence component could have left employment earlier. We analyzed the studies to determine how likely an influence of an HWE was by checking whether the primary studies we included controlled for the confounding variables that are commonly considered to modify the strength of the HWE (e.g., gender, occupational class, length of employment; Baillargeon, 2001; Choi, 2000), and most of these studies did. Thus, the finding that younger employees are more vulnerable vis-a-vis high quantitative work demands mainly drawing from crystallized intelligence components might not be strongly affected by the HWE.

Additionally, our review confirmed our proposition that *job autonomy* illustrates the importance of having some freedom to influence one's working conditions in older age groups. The rather solid number of significant interactions additionally underlined the crucial role of autonomy for successful aging (Baltes & Baltes, 1990). Unexpectedly, however, high strain jobs turned out to be especially hazardous for the health of younger employees. Here, the HWE might offer one explanation: Employees can remain in their jobs in the long run only when they are rather resilient vis-à-vis these work characteristics and, hence, the remaining group may be relatively healthier than their younger counterparts. Previous studies regarding high-strain jobs and age effects have reported corresponding findings and interpreted them similarly (e.g., Bosma et al., 1997).

Concerning *meaningful work*, the related result indicated an increasing relevance with age, and only up to an age of 54. Empirical findings concerning associations between age and the importance of generativity goals (e.g., meaningful work) are in line with the theoretical assumptions of SST (i.e., demonstrating generativity as a relevant work value particularly of older employees; e.g., Hertel & Zacher, 2015; Kooij et al., 2011). However,

our finding was based on only one interaction and should hence be interpreted with caution.

The importance of nonlinear analyses in terms of age-specific research was demonstrated by the findings on *possibilities for development*. We theoretically expected a linear association, but the results revealed a higher relevance for the oldest in comparison with the youngest age group, whereas the middle-aged group was found to be the most vulnerable. One explanation for this partly unexpected finding could be knowledge-related motives: According to SST (Carstensen et al., 1999), these are more important for younger than for older people, that is, middle-aged employees may still suffer from a lack of opportunity to pursue knowledge acquisition, but their health might not yet benefit as much from the positive effects of mental activities. This combination might cause the particular vulnerability due to a lack of possibilities for development in middle-aged employees. The findings regarding possibilities for development can be considered rather robust as both the number of extracted interactions was relatively high and the number of nonsignificant findings was relatively low.

The frequency of nonsignificant interactions for *interpersonal relations* was also relatively low. Moreover, nonlinear analyses of interpersonal relations and age again seemed to be meaningful because the middle-aged employees were clearly most vulnerable to ill health when their social relationships and quality of leadership were poor. Thus, our results underline findings that demonstrated an inverted U-shaped relationship between strain and age (Rauschenbach & Hertel, 2011). This higher vulnerability of middle-aged employees may be due to their stressful life phase, which is typically characterized by high work responsibilities and caregiving tasks, and their lower emotional regulation effectiveness in comparison with older employees (Scheibe & Zacher, 2013). Concerning a potential impact of the HWE, our analysis of the primary studies showed that most of the studies that analyzed interpersonal relationships controlled for the relevant confounding variables. Hence, the findings may not be strongly influenced by the HWE.

In terms of *job insecurity*, older employees were not identified as being at the highest risk for poor health as expected. The results demonstrated no consistent effect of the interaction between job insecurity and age on health. The specific and different origins of job insecurity might offer a possible explanation for this unexpected finding. For instance, temporary employment appeared to have a pronounced effect on health especially for older employees (Ervasti et al., 2014). These adverse effects may be due to related personal and financial threats, which tend to be more severe in later career stages. On the other hand, general job insecurity had a stronger association with health for younger employees (Rugulies et al., 2008). It may stem from lower emotion regulation competencies that are more characteristic of younger ages (Scheibe & Zacher, 2013). These latter results are in line with a recent meta-analysis that demonstrated a stronger association for younger than for older employees (Keim et al., 2014). Alternatively, the HWE could also have affected the results and may have created the impression that the oldest age group is healthier than it actually is because only a few of the included primary studies adjusted for relevant confounding variables.

The small number of primary studies involving *work–life conflict* strongly limits the conclusions that could be drawn from the related findings. The balance between the numbers of nonsignificant and significant findings involving organizational justice also did not allow for clear conclusions. Additionally, and contrary to our proposition, the findings did not demonstrate a decrease in the relevance of this work characteristic with age. Rather, they showed the highest vulnerability for middle-aged employees and, thus, the HWE probably played a minor role. The specific vulnerability of middle-aged employees might again be caused by the combination of this rather stressful life phase with emotional regulation effectiveness that is not as mature as that of older individuals (Scheibe & Zacher, 2013). In sum, a more differentiated analysis considering different moderator variables is desirable with regard to organizational justice.

3.6.2 Limitations and Future Directions

Our review addressed some of the constraints of previous research by presenting a systematic synopsis of moderation effects involving a variety of psychosocial work characteristics and age. Furthermore, we formed consistent age groups that enabled an integration of the findings across different age-group classifications as used in the primary studies. Although we chose the schema that fit the given classifications best, our classification necessarily resulted in some information loss. Also, the differentiation into three age groups did not fully mirror how heterogeneous and highly individual life courses and age processes are (Kohli, 2007). To address this issue and to gain a deeper understanding of the underlying processes of age-dependent vulnerabilities, future research could combine different operationalizations of the key construct age (e.g., self-perceptions or psychological age; De Lange et al., 2006) and underlying age-related motives (e.g., Kooij et al., 2011).

Also, the file drawer effect might play a certain role in our review because we did not consider gray literature or methods that could test for this potential bias (Rothstein et al., 2006). However, we assume that this bias was not particularly pronounced for our review because we were able to include a substantial portion of nonsignificant interactions (39%). Moreover, despite the relatively high overall proportion of nonsignificant interactions, we identified characteristics with a high proportion of significant interactions: autonomy, high strain, and interpersonal relations. Thus, age seems to play a crucial role in the relationships between these characteristics and ill-health. However, statistical adjustments for the potential impact of the HWE are desirable to allow for more definite conclusions regarding the observed nonsignificant results.

Another potential methodological problem concerns the combination of cohort, age, and periodic effects (Palmore, 1978). By keeping the publication period of the included studies relatively short (from 2000 to 2017), we tried to alleviate related problems. Finally,

the low absolute frequency of studies for some domains (i.e., meaningful work, work–life conflict, and social inclusiveness) prevented us from drawing clear conclusions. Future research on these rarely studied psychosocial work characteristics is therefore desirable. However, our study reported aggregated results across several primary studies. Thus, the outcomes we observed were as robust as currently possible and thus mirrored the "state of the art" in this research domain.

3.6.3 Practical Implications

Our findings confirmed the relevance of good psychosocial work design in general because we did not find contradictory relationships for different age groups. More specifically, our review indicated that vulnerabilities for specific working conditions also varied across age groups and that a lifespan perspective on work design is meaningful: It is important to explore all ages and career stages (Rudolph, 2016). Given recent and future demographic changes, an age-sensitive work design is critical owing to the increasing necessity of maintaining and enhancing employee health across the lifespan.

Whereas older employees and their vulnerabilities have often been highlighted in extant research (e.g., Aittomäki et al., 2003; Hasselhorn et al., 2014), our analysis suggested the importance of considering specific vulnerabilities for younger and middle-aged groups as well. Stakeholders who are in charge of work design are encouraged to tap the potential of improving psychosocial work quality depending on their employees' ages. For instance, work–family balance, a high quality of interpersonal relationships in the workplace, or organizational justice are particularly relevant for the health of younger and middle-age employees. For instance, strengthening organizational justice for these younger or middle-age employees and introducing participative elements in decision-making processes or interventions is recommended (Tenhiälä et al., 2013). Such measures are important because employees from these age groups less often hold leadership positions and thus do not automatically have a voice or play a role in organizational decisions. To give another

example that particularly concerns younger and middle-aged employees, a leadership style involving the provision of regular and appreciative feedback can foster a positive relationship between supervisors and followers (Weigl et al., 2012).

For older employees, job autonomy and possibilities for development were found to be especially critical psychosocial work characteristics. Thus, it would be important for organizations and line managers to increase autonomy for this group (e.g., with respect to time scheduling or work processes). Introducing job rotation opportunities to facilitate successful aging at work may also be worth exploring (Weigl et al., 2013).

Finally, the assessment of psychosocial risks is a necessary first step for organizations to shape work characteristics in an age-sensitive way and to ensure a standard of good work design. It not only enhances individual health (Leka et al., 2011), but also promotes desirable organizational behavior (e.g., reduced turnover intentions; Liebermann et al., 2013a). Tailoring psychosocial work characteristics to age-related vulnerabilities preferably early in the lifespan is essential for preventing effects of unhealthy work design, which are likely to be cumulative and apparent in the long-term (Ganster & Rosen, 2013).

3.6.4 Conclusion

Aging and the shrinkage of the working population in most industrialized countries make it more important than ever to preserve the health of all employees. To successfully navigate these developments, companies need to be aware of age-sensitive psychosocial work designs. Our review illustrates the virtue of age-related analyses for moving toward an age-sensitive psychosocial work design and for tailoring measures of occupational health promotion to the needs of different age groups. There is a need for further research that can complement our findings in terms of understudied work characteristics to meet the challenges of the changing world of work.

3.7 Electronic Supplementary Material (ESM)

The electronic supplementary material is available with the online version of the

article at https://doi.org/ 10.1026/0932-4089/a000330

ESM 1. Supplementary file: Search Term (see Appendix C)

4. Study 2 – How does Telework Modify Informal Workplace Learning and How Can Supervisors Provide Support?

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4.1 Introduction

Fast changing working contexts that derive from global competition and increasing digitalization require employees and organizations to constantly adapt. Ongoing development of competences has become an increasingly important strategic factor, hence informal workplace learning (IWL) is of growing interest (Tannenbaum & Wolfson, 2022). IWL positively stimulates cognitive, motivational, and behavioral processes and gains in acquisition of skills and performance (Cerasoli et al., 2018). Besides *individual factors*, crucial antecedents for workplace learning are *organizational conditions* such as task characteristics, social relations, and learning opportunities (Decius et al., 2021b; Jeong et al., 2018). The COVID-19 pandemic accelerated the increase in telework (i.e., working from home), meaning that employees and their job tasks are relocated from the traditional office setting to remote working environments, physically separated from supervisors and colleagues. Telework is debated with respect to consequences for the individual, team and organization (e.g., performance, job satisfaction; Gajendran & Harrison, 2007). To our knowledge, it has not yet been examined specifically how telework might act to alter IWL. However, there are a few studies that loosely deal with the two topics. For example, Bjursell et al. (2021) describe in their review about telework that it may have a broad impact on lifelong learning. Furthermore, in their empirical study on informal learning at work, Gerards et al. (2020) investigate news ways of working but do not specifically focus on telework. In this regard, by developing a framework, we try to make a strong theoretical contribution to explain the impact of telework on IWL.

Table 9

Conceptual framework of telework specifics, anticipated consequences for informal workplace learning (IWL) and possibilities for supervisor support

Processes	1) Social processes	2) Self-regulatory processes	3) Role boundaries
a) Specifics of telework vs. traditional office work	• *Quantity of relationships:* Fewer opportunities for incidental social contacts, informal communication and meetings; fewer opportunities to perceive how others work; less stimuli for learning by colleagues. • *Quality of relationships:* Digital and virtual communication, less rich communication; more asynchronous communication; lower quality of relations with coworkers; less social support from colleagues and supervisor; less exposure to organizational values, meanings and standards.	• *Time management:* Private (vs. collective) time allocation; higher self-regulation opportunities and requirements due to higher autonomy and time control. • *Availability:* Higher self-regulation needs regarding expectations concerning availability. • *Disturbances:* Fewer work-related social disturbances, interruptions, and conflicts.	• *Disturbances:* Less work-related interruptions; more private-related disturbances due to less segmentation of life domains. • *Role conflicts:* Less work-life conflicts; easier role transitions due to higher integration. • *Role ambiguity:* Higher role ambiguity due to poor communication.
b) Anticipated consequences of the respective process for teleworker's IWL and its components	• *Intent to learn*: Less pronounced due to less learning stimuli and less social identity cues. • *Experience/action*: Less pronounced due to less learning stimuli and less social identity cues; less model learning. • *Feedback*: Restricted feedback from colleagues and supervisors; higher inhibition to ask for feedback due to less informal communication; less feedback and in turn less motivation to learn and reflect; more structured and goal-oriented feedback-seeking due to less informal communication and less external feedback. • *Reflection*: Less pronounced reflection due to less stimuli.	• *Intent to learn:* More opportunities and pursuing of professional goals; more intrinsic intent to learn. • *Experience/action, feedback and reflection*: More (concentrated) opportunities for experience, feedback and reflection due to higher autonomy; more self-discipline and proactivity necessary to reserve and use flexibility for experiencing, reflection and gathering feedback from colleagues and supervisors.	• *Intent to learn:* Less intrinsic and extrinsic intent to learn due to unclear role expectations. • *Intent to learn, experience/action, feedback and reflection*: Less learning triggers due to less spontaneous work-related interactions and in turn less intrinsic and extrinsic intent to learn, experience, seeking feedback and reflection; less opportunities for IWL due to higher private distractions.
c) Possibilities for supervisors to support IWL	• *Social exchange:* Introduce routines for informal communication; stimulate professional exchanges e.g., by strengthening task interdependence; provide resources for sharing experiences; apply communication-enhancing technologies; organize fixed team attendance days to facilitate knowledge sharing, identification and to improve social relationships. • *Feedback:* Offering feedback and model learning. • *Trust:* Create trust within teleworking teams to enhance knowledge sharing, reduce professional isolation and ensure an error-related learning climate.	• *Resources:* Create informal learning opportunities by e.g., defined learning times; discuss and clarify availability times; professional support of self-regulation strategies. • *Motivation*: Communicate the usefulness of IWL; create a communication routine that encourages experience, feedback and reflection.	• *Clarification:* Discuss productive times that meet private and professional needs; reduce role ambiguity by expressing tasks, responsibilities, and goals; address risks of work-life conflicts; clear availability expectations and enable undisturbed times. • *Motivation:* Offer extrinsic incentives and support intrinsic intents to learn to specify role expectations.

In our article, we develop a conceptual framework of how telework changes components of IWL. We argue that employees' separation from their traditional workplaces in their offices modifies spatial and temporal boundaries of work and the work's nature itself also affecting IWL. Corresponding with Allen et al.'s (2003) approach and Gajendran and Harrison's (2007) categorization, we focus on three telework-related processes that influence central work outcomes, more precisely *social relationships* (social processes), *self-regulation* (self-regulatory processes), and *role boundaries*. Furthermore, we develop suggestions how *supervisors* can positively influence these processes within the IWL framework (cf. Figure 4). We base our propositions on the octagon model of IWL (Decius et al., 2019) and several other theories. By presenting our propositions within the conceptual framework, we aim to explain how telework modifies opportunities for IWL and discuss the role that supervisors can play in this context (cf. Table 9).

4.2 Telework

Information and communication technologies (ICTs) have a profound impact on the organization of work because they enable the detachment of work from the traditional office (Bosua et al., 2017). Digitalization and globalization are current key drivers for the significant increase of telework, and the COVID-19 pandemic accelerated this trend (e.g., Kauffeld et al., 2022). Nearly a quarter of all employed persons in Germany has worked at least occasionally from home in 2021 (Destatis, 2022).

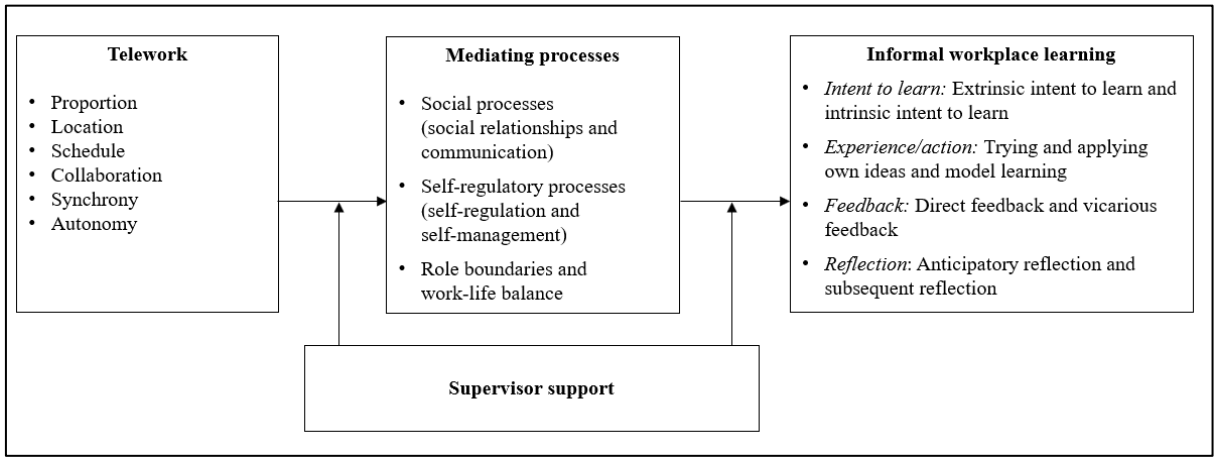
Various terms are used to describe working away from the workplace e.g., telework, remote work, mobile work, virtual work or new ways of working (Beauregard et al., 2019; Bailey & Kurland, 2002). During the pandemic, the term "working from home" became common referring to employees working remotely from home, with and without formal telework regulations. In accordance with Nicklin et al. (2016) we refer to "telework" as 'the proportion of job function(s) performed by an employee away from both other employees and the organization's established physical base of operations, using various forms of information

and communication technologies to maintain a virtual presence' (p. 46). However, telework can vary widely in terms of a range of factors: Proportion (part to full time), location (fixed to mobile), schedule (fixed to varied), collaboration (low to high), synchrony (serial to concurrent), and autonomy (low to high; Nicklin et al., 2016). Hence, telework differs along these factors, and further between and within employees over time. Moreover, and in respect to traditional office work, telework varies in its similarities or differences to regular office work depending on the specific factors of telework and depending on the job itself (cf. Figure *4*). In turn, both forms can be regarded as a continuum, the boundaries are becoming increasingly blurred.

Telework is associated both with benefits and disadvantages organizations and employees perceive. While benefits are related with e.g., cost savings, higher productivity, higher work-life balance, increased flexibility, and higher job satisfaction, disadvantages include management of teleworkers, workplace culture, work-life blurring, isolation, and lower quality relationships (Bjursell et al., 2021; Bosua et al., 2017). So far, telework research has focused mainly on job attitudes, performance, and well-being, and has analyzed work characteristics, such as social support or perceived autonomy (Gajendran & Harrison, 2007; Wöhrmann & Ebner, 2021).

Figure 4

Proposed model of telework, informal workplace learning and supervisor support



4.3 Informal workplace learning

Work-related learning enhances the acquisition of knowledge, skills, abilities, and other resources (Tannenbaum & Wolfson, 2022). These can be gained, for instance by learning on the job (informal learning), near the job (self-regulated learning) and off the job (formal learning; Decius et al., 2022). Formal learning is highly structured and institutionally organized (Tannenbaum et al., 2010) whereas self-regulated learning and informal learning are not. Self-regulated learning focuses on self-imposed learning goals while IWL concentrates on solving a problem that arises from the work itself (Decius et al., 2022). We refer to Cerasoli et al.'s definition (2018) for IWL who describe it as "... predominantly self-directed, intentional, and field based. Informal learning behaviors are not syllabusbased, discrete, or linear" (p. 204).

Forms of IWL are applying new ideas, looking how others work, asking colleagues about their experiences or reflecting about work. IWL takes place outside formally designated learning contexts (Decius et al., 2019). Although the majority of learning occurs in informal, "natural" learning settings, research and practical activities concentrate on formal training. One reason for this seems to be its sporadic, dynamic and self-guided nature (Tannenbaum et al., 2010). However, studies demonstrate the value of IWL for knowledge and skill acquisition, performance, and work-related attitudes (Cerasoli et al., 2018; Decius et al., 2021a, c). We aim at exploring how telework changes IWL and develop a theoretical framework. For this, we refer to the *octagon model of IWL*. It is in accordance with Cerasoli et al.'s (2018) definition of informal learning which is a multidimensional approach including motivational, cognitive, and behavioral processes (e.g., Tannenbaum et al., 2010). It builds on theoretical considerations, was applied to distinct groups (e.g., blue-collar and white-collar, students; Decius et al., 2019, 2021c, 2021b), and is operationalized by a validated measure (IWL scale; Decius et al., 2019).

The octagon model is an extension of the dynamic model of informal learning

(Tannenbaum et al., 2010). It builds on eight components along four factors (Decius et al., 2019, 2021b): 1) Intent to learn with the components "*intrinsic intent to learn*" and "*extrinsic intent to learn*", 2) experience/ action with "t*rying and applying own ideas*" and "*model learning*", 3) feedback with "*direct feedback*" and "*vicarious feedback*", and 4) reflection with "*anticipatory reflection*" and "*subsequent reflection*". An individual may enter the learning process at any stage and undergo one or more of the eight components. Learning is presumed to be particularly efficient when all components are involved (Tannenbaum et al., 2010). The process includes intentional facets in the preparatory phase (intent to learn), behavioral facets in the action phase (feedback and experience/action) and cognitive facets in the consolidation phase (reflection; Decius et al., 2022). These behavioral facets of IWL are in accordance with behavioral elements of recent comprehensive frameworks, for example the CAM-OS framework by Tannenbaum and Wolfson (2022) which extends IWL behaviors further by different personal and situations readiness factors for enabling IWL.

4.4 Development of propositions

The focus of our theoretical paper is to explore how IWL is affected by changed working conditions due to telework and to develop a correspondent conceptual framework. For a systematization of the working conditions, we choose the categorization developed by Allen et al. (2003). They assume that telework generally affects work-related outcomes via three processes, namely social processes, self-regulatory processes, and role boundaries (cf. Figure 4). This is in accordance with Gajendran and Harrison's (2007) framework for the consequences of telework which states similar psychological mediators: Relationship quality corresponds to social processes, perceived autonomy to self-regulatory processes, and work-family conflicts to role boundaries. In terms of IWL, we refer to the octagon model of IWL and the input-process-output model of IWL by Decius et al. (2021b), which includes working conditions that facilitate and hamper IWL. We combine these with Allen et al.'s (2003) categorization and develop propositions and a theoretical framework how

telework modifies IWL. For this, we apply theories from work and organizational psychology (e.g., job demands-resources model, Bakker & Demerouti, 2017; self-determination theory, Deci & Ryan, 2008), theories regarding telework processes (e.g., border theory, Clark, 2000) and recent empirical results. Along these three processes we demonstrate their specifics in respect to telework compared to traditional office work (cf. Table 9, row a). Furthermore, we take our analysis one step further by identifying approaches to support informal learning among teleworkers. Here, we address specifically the role of supervisors and clarify how they can support IWL of teleworkers. The basis for our considerations is research on e-leadership (e.g., Avolio et al., 2000; Contreras et al., 2020) and the main theory in this context, DeSanctis and Poole's (1994) adaptive structuration theory. Our conceptual framework with the assumed associations and possibilities of supervisory support are displayed in Table 9 in detail. Here, we emphasize that the expected effects depend on the specific characteristics of telework because research recommended to consider telework as a continuous rather than a nominal variable (e.g., considering telework extent; Gajendran & Harrison, 2007; Sardeshmukh et al., 2012; Wöhrmann & Ebner, 2021). We assume not only effects of telework frequency (i.e., proportion) but also in respect to other factors (e.g., collaboration, synchrony). Therefore, the expected effects of telework on IWL represent a rough and average expectation, and they may vary according to the accentuation of different characteristics (e.g., proportion, collaboration, autonomy). In the following we develop three propositions according to the assumed mediating processes and one proposition according to the role of supervisors. Due to text length restrictions, we display our considerations in Table 9: Illustrations in terms of propositions 1 to 3 are shown in columns 1 to 3 of Table 9 while illustrations regarding proposition 4 are shown in row c.

4.4.1 Social processes, telework and informal workplace learning

Telework has implications for relationships and communication with supervisors and

colleagues (cf. Table 9). Instead of face-to-face meetings, office talks, staircase conversations or joint lunch breaks, telework relies on electronic communication and collaboration tools (Allen et al., 2003; Bosua et al., 2017). In particular, teleworkers perceive firstly *less rich communication* cues and opportunities to give and receive feedback (Van Steenbergen et al., 2018). Communication channels differ in their information richness with face-to-face communication as the richest (e.g., Dennis et al., 2008). Due to the restrictions in telework, misunderstandings, weakened collaboration, and a decline in feelings of belonging are more likely to occur (Van Steenbergen et al., 2018). In addition, telework is characterized by more asynchronous communication compared to traditional office work, which can hamper communication performance as well (Dennis et al., 2008). Hence, appropriate means and IT-tools are important for an effective communication as technology determines the types of interactions (DeSanctis & Poole 1994). Secondly, the resources *social support* and *quality of relationships* decrease when employees telework extensively (Sardeshmukh et al., 2012). Thirdly, *isolation* is another factor triggered by telework. Despite networking possibilities, frequent telework is related with higher perceptions of social and professional isolation due to fewer face-to-face interaction, lower social presence and fewer learning opportunities (e.g., Beauregard et al., 2019). As (social) relatedness is a basic psychological need for motivation (Deci & Ryan, 2008), perception of isolation could reduce motivation to IWL as well.

Due to these modified social processes, we expect fewer opportunities for all IWL components (e.g., extrinsic intent to learn, direct feedback) because social relationships are a significant antecedent of IWL (Cerasoli et al., 2018; Decius et al., 2021b; Jeong et al., 2018). Learning from others is a central resource for IWL (Noe et al., 2013), and social support enables receiving feedback, applying model learning and fosters motivation and engagement (Bakker & Demerouti, 2017; Hüffmeier & Hertel, 2011). Clearly defined structures and social routines provide learning opportunities via knowledge exchange and feedback

(Beauregard et al., 2019; Welk et al., 2022) but interaction in telework is more formally scheduled and less informal than interactions in the office (Bjursell et al., 2021). Depending on how much the job is characterized especially by collaboration (low vs. high) and schedule (fixed vs. varied), telework affects social processes and therefore IWL to a different extent. Thus, telework likely reduces social processes which play a fundamental role within the octagon model; consequently, we assume that telework modifies IWL (cf. Table 9, column 1).

Proposition 1: Telework reduces opportunities for IWL via social processes.

4.4.2 Self-regulatory processes, telework and informal workplace learning

ICTs enable employees to choose the place and the time to work and make decisions flexibly without direct supervision (Kauffeld et al., 2022). This increased *autonomy* is presumed to be a core job resource to achieve work goals and stimulate personal growth, learning and development (Bakker & Demerouti, 2017). Also, according to self-determination theory (Deci & Ryan, 2008) it fulfills personal needs.

However, autonomy requires self-leadership and self-regulating behavior (Bandura 1991; Mander et al., 2021), i.e., high autonomy enables *and* requires self-regulation for teleworkers (cf. Table 9). While ICTs offer flexibility and control over communication for employees, they simultaneously generate feelings of constant availability leading to a perception of reduced autonomy (e.g., Kauffeld et al., 2022). This "*always-on culture*" can be linked to the mutual investment approach (Tsui et al., 1997), according to which employees are willing to contribute more time because they receive the employer's benefit to work remotely (Charalampous et al., 2019). These perceptions might add to further self-regulation needs. This is contrasted with office routines (e.g., breaks) that can provide structure and reduce the need for self-regulation. However, teleworkers do not experience disruptions that are typical for work situations in the office (e.g., requests, informal conversations, office-based politics) which reduces stress, enhance the chance to focus on

tasks more effectively, and strengthens autonomy in self-management (cf. Beauregard et al., 2019).

Concerning IWL, autonomy is a relevant antecedent for the self-directed character of IWL for several reasons (Cerasoli et al., 2018; Decius et al., 2021c). Firstly, employees need sufficient resources to intentionally engage in IWL. An autonomous functioning implies opportunities for planning one's productivity to work more efficiently and for learning opportunities, i.e., applying new ideas, seeking tips and experiences from colleagues, or reflecting on learning processes and experiences. Secondly, flexibility can foster IWL and intrinsic intent to learn due to the positive motivational influence of autonomy (Bakker & Demerouti, 2017). Whether employees take advantage of autonomy or not depends on their self-regulation abilities and individual predispositions (Decius et al., 2021b), and on their social embeddedness and role boundaries (see below). Table 9 (column 2) shows in detail how self-regulation may affect IWL and its components. Again, we assume that telework affects self-regulatory processes and therefore IWL to a specific extent, depending on the telework characteristics itself (e.g., proportion, schedule, or synchrony). Thus, we propose the following:

Proposition 2: Telework increases opportunities for IWL via self-regulatory processes.

4.4.3 Role boundaries, telework and informal workplace learning

Whereas office work indicates clear separations in time and place from work and nonwork domains, telework often has highly integrated roles with flexible and permeable boundaries between both (Allen et al., 2003). On the other hand, telework allows individuals to fulfill both work and private responsibilities and combine roles more easily (Beauregard et al., 2019). Research indicates less *work-family conflicts* for teleworkers (e.g., Gajendran & Harrison, 2007). According to border theory (Clark, 2000), employees differ in their preference and possibilities to segment or integrate their professional and private roles. In

line with this, time flexibility allows employees to schedule work optimally, hence the negative effects of blurred boundaries and role conflicts can be diminished (Lott & Abendroth, 2023). Similarly, telework indicates less role conflicts because employees have a greater control over disruptions, perceive less interruptions and less unanticipated work-related requests (Sardeshmukh et al., 2012; Wöhrmann &Ebner, 2021). However, blurred boundaries are also related to role ambiguity, which is demanding and occurs when employees lack clear information about their role (Bakker & Demerouti, 2017). Role ambiguity is higher for teleworkers because they face limited communication cues within interactions regarding requirements for private and professional roles (Sardeshmukh et al., 2012).

If teleworkers perceive a better balance of private and professional demands, time gains could generally increase opportunities for IWL because time allows reflection, feedback and trying to realize own ideas (Jeong et al., 2018; Marsick & Volpe, 1999; Tannenbaum et al., 2010). On the other hand, blurred boundaries can also increase private interruptions and time pressure in the short-term which hampers engagement in feedback seeking and reflection (Wolfson et al., 2019) and cause stress, diminish learning performance and motivation to learn (Cerasoli et al., 2018). In addition to role conflicts and time-based conflicts, role ambiguity is relevant for IWL. It is linked with team conflicts and less psychological safety due to unclear roles and tasks, which in turn hampers IWL (Frazier et al., 2017). Table 9 (column 3) displays potential effects of role boundary management requirements for all components of the octagon model in more detail. Here, we would like to recall the telework factors (especially e.g., location, synchrony, schedule) that may affect role boundaries and in turn IWL. Hence, we propose the following:

Proposition 3: Telework reduces opportunities for IWL via role boundaries.

4.4.4 Supervisor support, telework and informal workplace learning

Generally, reviews on IWL demonstrate supervisor support as a significant

situational antecedent for IWL (Cerasoli et al., 2018; Decius et al., 2023a; Tannenbaum & Wolfson, 2022). However, telework enables and forces supervisors to redefine their role (Avolio et al., 2000; Dambrin, 2004), and Contreras et al. (2020) report in their review that supervisors need to develop 'new abilities to establish a strong and trustworthy relationship with their employees to maintain their competitiveness' (p. 1). This ist in line with adaptive structuration theory (DeSanctis & Poole, 1994) that assumes that ICTs transform leadership and possibilities for supervisory support. For several reasons, we assume that supervisors are in a crucial position to elicit benefits of telework and to foster IWL. Our considerations are based on various leadership styles (e.g., transformation, servant or empowering leadership). These include promising elements to strengthen IWL like 'intellectual stimulation', 'individualized consideration', 'helping subordinates grow and succeed' and 'empowering subordinates'. We pick up on these in our descriptions below and in our suggestions (cf. Table 9, row c).

First, research shows the significance of leadership for work-related outcomes within telework arrangements (Beauregard et al., 2019). Prior results demonstrate positive associations between telework conditions and *employee-supervisor relationships* (e.g., Gajendran & Harrison, 2007). Possibly due to the lack of direct observation, supervisors are paying greater attention to structure communication in telework. Brown et al. (2021) emphasize the significance of task-focused and relationship-focused leadership for *virtual team performance*. Lott and Abendroth (2023) further indicate the importance of *trust and fairness* of supervisors concerning their employees' affective commitment in virtual work settings.

Second, supervisors can shape the three described processes that trigger telework to strengthen IWL. Regarding social processes, they could promote informal communication, social support, a learning climate, and trust (e.g., Decius et al., 2021b), and make decisions concerning task interdependence, technical and software applications, communication forms

and intensity (Dennis et al., 2008; Maruping & Agarwal, 2004; cf. Table 9, cell 1c). In terms of *self-regulation*, they can regulate expectations concerning the employees' availability and strengthen employees' self-regulation capabilities (Tannenbaum & Wolfson, 2022; cf. Table 9, cell 1b). With respect to *role boundaries*, supervisors could reduce role ambiguities and assist in establishing a better work-life balance, for instance, offering team rules (cf. Table 9, cell 1c). Furthermore, supervisors can design telework arrangements concerning the frequency and flexibility of telework. Here, regular team attendance days may compensate for negative effects of telework. Also, Tannenbaum and Wolfson (2022) refer in their CAM-OS framework to the approach of manager support for strengthening IWL.

Lastly, supervisors can influence IWL directly (Decius et al., 2021b; Gerards et al., 2020; Zia et al., 2021). Referring to the octagon model, supervisors can *design IWL conditions* proactively by creating feedback routines and act as a learning model. Similarly, the work design growth model (Parker, 2017) emphasizes that work design (and thus the design of telework) is a very promising approach for learning and development as work characteristics shape behavioral, cognitive and motivational processes and in turn support a change in skills and cognitive development. Additionally, they could initiate learning processes by encouraging teleworkers to try out new ideas or creating extrinsic learning incentives. These opportunities tie in with Ellinger and Cseh's study (2007), showing that learning-committed leadership supports IWL because supervisors can serve as developers, visibly making space for learning, or instilling the importance of sharing knowledge. Depending on the specific design of telework (especially e.g., collaboration, schedule), this can be achieved to varying degrees. In general, we propose that supervisors can foster IWL in telework arrangements.

Proposition 4: Supervisor support can beneficially affect the relationship between telework and IWL.

4.5 Discussion

Telework shifts work to private spaces, and it is associated with flexibilization and adaptation necessities for employees. Working physically distanced from peers and supervisors changes work habits and opportunities for IWL because social exchange is impaired and requirements of self-regulation and role boundary management increase. Our conceptual framework describes how these modifications affect all components of the octagon model of IWL defining a changed learning infrastructure. Opportunities for IWL are diminished due to restricted communication, reduced social relationships and fewer learning cues. Concerning autonomy, this resource increases by telework, allows for more opportunities for IWL and requires more self-regulation. In sum, employees are more left to their own resources, and it depends on their skills regarding social processes, self-regulation and role boundaries how well they cope with these changes. As supervisors could help maintain IWL, organizations should pay attention to these developments and promote supervisors to take advantage of their opportunities to support learning on the job. Our assumptions extend and support recent research about learning in digital environments, i.e., the significance of the socio-technical environment for the perception of learning opportunities (Decius et al., 2022) and of feedback for IWL in the context of new ways of working (Gerards et al., 2020).

4.5.1 Theoretical implications

We theoretically applied the octagon model of IWL to the specific context of telework and underline its relevance and appropriateness for virtual working contexts in general. Previously created for blue- and white-collar workers, the IWL scale should be expanded regarding telework. Adaptations could include the integration of further *sources* of learning like “learning from non-personal resources” (Noe et al., 2013) and “learning from new media” (Kortsch et al., 2019) into the model and into the related measure (IWL scale; Decius et al., 2019). This would enhance their application and considers the increasing use of media at work (cf. Table 10).

Table 10

Recommendations to adapt Items of the IWL scale to telework arrangements

IWL components	Adaptations
Experience/action[1] (Trying and applying own ideas, model learning)	• Expand sources for learning with respect to non-personal resources and new media. *('I search for physical and digital resources to learn something new.'[2])* • Emphasizing self-regulation needs. *('I consciously take time to try out new ideas.'[3])* • Emphasizing rich communication for model learning. *('I use rich communication channels to understand how others work.')* • Reference to the organization's place can be omitted. *('I look at how others work [in the company] to improve my work.'[3])*
Feedback (Direct feedback, vicarious feedback)	• Emphasizing self-regulation needs. (*'I consciously take time to ask for feedback.'*[3]) • Emphasizing rich communication. (*'I use rich communication channels to receive feedback.'*)
Reflection (Anticipatory reflection, subsequent reflection)	• Distinct focus on the learning process for knowledge work. *('I think about how I could improve my learning process.'[2])* • Emphasizing self-regulation needs. *('I think about whether I have sufficient learning opportunities to improve my work.'[2]; 'I consciously take time to think about how I can improve my work habits.'[3])* • Emphasizing role boundary management. *('I think about how I can organize my work to balance private and professional needs.')*

[1] For the components "Intrinsic intent to learn" and "Extrinsic intent to learn", adaptations seem to be not necessary. [2] Adapted from Lee (2022). [3] Adapted from Decius et al. (2019).

4.5.2 Practical implications

Our conceptual model provides relevant practical implications for the promotion of IWL in digital working contexts. Supervisors have several options at their disposal to design

telework (e.g., frequency or flexibility of scheduling; Allen et al., 2003) and to enable opportunities for IWL in everyday work (cf. Table 9, row c). HR management could further promote the value of IWL, train supervisors for instance regarding learning-committed leadership (e.g., task-related learning opportunities) and climate (Ellinger & Cseh, 2007). Specifically, regarding IWL in knowledge work, supervisors may become a motivator and designer of those arrangements rather than a controller (Dambrin, 2004). Further, Kemether and Mynarek (2023) emphasize the support of trust and informal relationships between employees (e.g., online escape games or informal meetings after the working day to improve team cohesion), and they recommend the development of communication principles for different communication channels. With respect to employees, HR management could also offer formal trainings to improve employees' skills in self-regulation, role boundary management, and in how they cultivate social exchanges while teleworking (Althammer et al., 2021).

4.5.3 Limitations and future research

First, we draw our propositions on a theoretical basis and on related empirical evidence, hence we encourage researchers to *empirically test* the propositions. As we focused our research on the described psychological processes rather than on single task characteristics, we recommend analyzing employees' perceptions of their telework arrangement with respect to social relationships (e.g., isolation), self-regulation (e.g., procrastination) and role boundaries (e.g., role conflicts) as well as the role of supervisors. *Longitudinal designs* could study and prove *reverse effects* of IWL and working conditions (cf. Decius et al., 2021a).

Second, detailed *characteristics of telework* should be incorporated into future research as the importance of the extent of telework for work-related outcomes is demonstrated (e.g., Wöhrmann & Ebner, 2021). We did not incorporate this in detail, but we assume that fewer telework day per week may compensate for potential detrimental effects

for IWL. Future research should integrate additional characteristics to study effects on IWL (e.g., scheduling, policies, individual initiative, media synchronicity, task interdependence).

Third, the integration of *personal characteristics* can contribute to the understanding of the proposed associations because the management of social exchange, self-regulation, and boundary management refer to individual behaviors. Here, personality factors and learning-related motives are of interest to be analyzed in terms of telework. They are well analyzed with respect to IWL (Cerasoli et al., 2018; Decius et al., 2019) but are not in terms of telework. Further, the study of individual regulatory focus could provide helpful insights (Wolfson et al., 2019) as well as age-related variables such as experience and motivation to understand how individuals deal differently with telework conditions and use opportunities for IWL (Jeong et al., 2018).

To expand our research further, we recommend specifying the differences not only between *conventional* and *virtual learning*, but also concerning *simulated learning* (Wood et al., 2020). This could contribute to recognize the underlying processes as a function of the work environment. Lastly, future research should recognize *social inequalities* of IWL opportunities in age groups or professions (cf. Bjursell et al., 2021).

4.6 Conclusion

In conclusion, we theoretically investigated the impact of telework-related processes on components of IWL. Regarding social relationships, the modification of both the quantity and quality of social contacts may affect IWL. Supervisors could support employees' IWL by fostering social exchange, feedback and trust. Concerning employees' self-regulation, telework changes requirements of time management, availability, and disturbances. Here, supervisors could provide resources and motivation to enhance learning opportunities. Regarding role boundary management, role conflicts, role ambiguity and disturbances are affected aspects in remote working conditions. The clarification of expectations, to motivate employees to learn informally and to teach them how to learn informally could be helpful

options to foster IWL. Overall, telework changes the infrastructure for IWL, and supervisors should adapt to these changes and accompany employees proactively.

5. Study 3 – Can Job-Related and Personal Resources Extend Occupational Future Time Perspective? The Mediating Role of Job Crafting

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5.1 Introduction

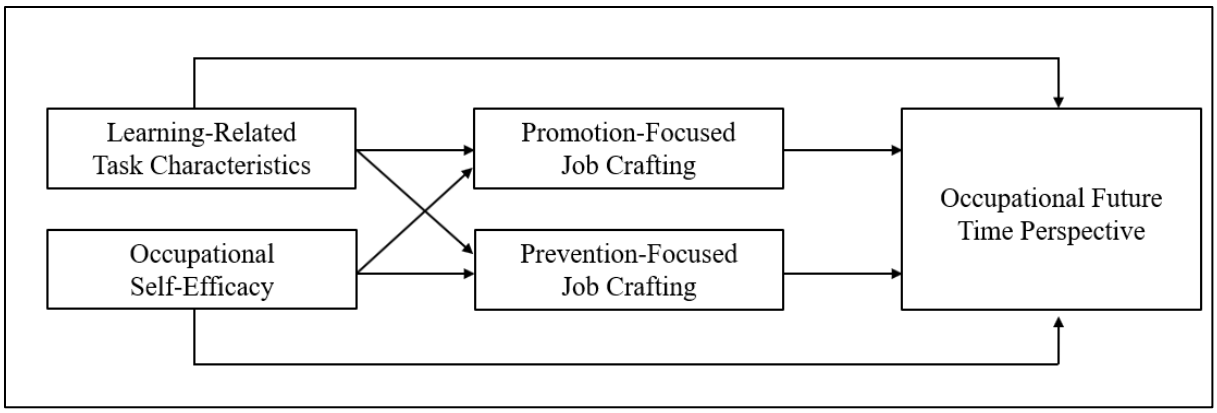
In times of aging workforces and skill shortages, organizations and supervisors need to prioritize the maintenance and enhancement of employees' work ability and motivation. More specifically, it is crucial to develop employees' careers and ensure that they remain motivated in terms of their occupational future for as long as possible. Organizational psychology and lifespan development research can significantly contribute to this endeavor by transferring approaches into practice. The concept of successful aging is considered a promising approach (Zacher, 2015; Zacher et al., 2018). It refers to the maintenance of employees' ability and motivation to continue working and suggests that employees actively adapt to individual, age-related, and environmental changes (e.g., Kooij, 2015; Kooij et al., 2020).

Because inter-individual differences increase with age, employees differ in how they respond to the aging process and, in turn, chronological age becomes a less reliable predictor of important organizational outcomes (e.g., work-related attitudes, engagement, or performance; Beier et al., 2022; Kooij, 2015). Therefore, research shows growing interest in age-related constructs for successful aging beyond chronological age. Occupational future time perspective (OFTP) is promising because it refers to employees' perceptions about their remaining opportunities and time at work (Zacher & Frese, 2009). Employees with the same chronological age can differ in their OFTP, and thus in their attitudes, beliefs, and perceptions of time in their working life (Weikamp & Göritz, 2015; Zacher & Frese, 2009). In addition, OFTP shows incremental predictive validity beyond chronological age regarding central work outcomes (e.g., work engagement, task performance), therefore it is a valuable construct in understanding aging processes and promoting successful aging at work (Rudolph et al., 2018).

For this reason, we aim to investigate how OFTP can be positively influenced and to ascertain whether job-related and personal resources function as its antecedents. A deeper understanding of how OFTP does not only predict relevant variables but is also predicted by such variables could provide companies with helpful information on how to retain skilled and older workers.

Figure 5

Conceptual model



From a theoretical perspective, the study of possible antecedents of OFTP would enable researchers to refine age-related theories and to gain insight into the development of OFTP (e.g., socioemotional selectivity theory, SST; Carstensen et al., 1999). This is of particular interest because most aging research has considered OFTP as a personal antecedent or mediating variable that shapes job attitudes, motivation, well-being, or job performance (Rudolph et al., 2018; Henry et al., 2017). Our study, however, responds to the call to adopt an inverted perspective and to examine OFPT as a criterion variable (Zacher & Frese, 2011; Weiss et al., 2016). Although recent research has confirmed single job characteristics (e.g., job autonomy) and personal factors (e.g., self-rated physical health) as predictors of OFTP (Rudolph et al., 2018), there is currently a lack of time-lagged studies on OFTP, which precludes insights into its development. In our two-wave study, we refer to the process model

of successful aging at work (Kooij et al., 2020) as an overarching framework for investigating antecedents and mediating variables of OFTP. Kooij et al.'s model integrates job-related and personal factors with a self-regulatory process that aims at achieving a person–environment fit and successful aging in turn. Based on this framework, we focus on (i) learning-related task characteristics as job-related antecedents, (ii) occupational self-efficacy as personal antecedent, and (iii) job crafting as the mediating self-regulatory process for the development of OFTP (for our research model, see Figure 5).

Our study contributes to the literature on aging in the workplace in several ways. Firstly, we focus on the role of OFTP within the process of successful aging at work, thereby addressing the growing interest in successful aging at work. By testing cross-lagged models, we aim to determine whether OFTP is affected by job-related resources, personal resources, and job crafting. If the outcomes turn out as expected, our study could inform related interventions for organizations. Secondly, we address the significant role of work design within theories of aging (e.g., Mühlenbrock & Hüffmeier, 2020; Zacher et al., 2016). To allow for broader job design recommendations, we go beyond the well-studied task characteristic of autonomy and its relation to OFTP by investigating the construct of learning-related task characteristics. Thirdly, we examine job crafting as a mediating variable that may explain the development of OFTP. Here, we differentiate between promotion- and prevention-focused job crafting to especially assess prevention-focused job crafting, which is considered dysfunctional (Zhang & Parker, 2019). By doing so, we contribute to the integration of theories of lifespan development and organizational psychology (Rudolph, 2016; Rudolph & Zacher, 2022). Finally, our time-lagged research design enables us to specify the role of OFTP, namely whether it is not only a meaningful predictor, but also a malleable criterion variable, and may thus function as a personal resource of successful aging. We thereby take up and connect with findings and suggestions from prior studies and the process model of successful aging at work propose (e.g., Kooij et al., 2017a; 2020).

5.2 Occupational Future Time Perspective and Its Antecedents

OFTP is a domain specification of the general construct of future time perspective (FTP), which Zacher and Frese (2009) have applied to the work context. OFTP is defined as "perceptions of the length of one's personal remaining time at work and beliefs about how many new goals, options, and possibilities one will have in the personal future at work" (Zacher & Frese, 2011, p. 292). FTP is an age-related construct with cognitive-motivational facets that change across the lifespan (Cate & John, 2007; Zacher & Frese, 2009) and a core construct of SST (Carstensen, 2006; Carstensen et al., 1999). SST states that perceptions of one's own FTP determine the selection and pursuit of two social goals, the acquisition of knowledge and the regulation of emotions. Individuals with an expansive FTP (e.g., young, healthy individuals) prioritize knowledge-related goals, acquire resources, and focus on opportunities and long-term goals. In contrast, individuals with a constrained FTP prioritize short-term and emotionally meaningful goals (e.g., meaning in [working] life, social embeddedness; Carstensen et al., 1999).

Organizational research views OFTP conceptually as a unique developmental predictor variable for central work outcomes (e.g., job satisfaction, organizational commitment, work engagement, employability, and job performance) with incremental predictive validity beyond chronological age regarding these outcomes (Rudolph et al., 2018). In their research, Zacher and Frese (2011) demonstrated that chronological age, job complexity, and job control predict OFTP. Subsequent studies confirmed health, age beliefs, and regulatory focus as predictors of OFTP (Weiss et al., 2016; Rudolph et al., 2018; Zacher & De Lange, 2011; Zacher & Rudolph, 2019).

The process model of successful aging at work (Kooij et al., 2020) defines successful aging at work as "the proactive maintenance of, or adaptive recovery (after decline) to, high levels of ability and motivation to continue working" (Kooij et al., 2020, p. 345). According to this model, successful aging is determined by a self-regulatory process that entails goal

engagement and disengagement strategies for the maintenance, adjustment, and restoration of an anticipated or experienced person–environment fit. In the context of our study, we examine learning-related task characteristics as job-related antecedents and occupational self-efficacy as a personal antecedent of OFTP. Due to its developmental characteristics and its relationship with chronological age, OFTP is closely related to successful aging at work (Rudolph et al., 2018). Specifically, we build Zacher and Frese's (2009, 2011) initial work, who emphasized the malleability of OFTP and considered it an indicator of successful aging.

5.2.1 Learning-Related Task Characteristics and Occupational Future Time Perspective

To address employees' adaptability to the dynamic working world, organizations are increasingly recognizing the importance of learning and development (Tannenbaum & Wolfson, 2022). Informal workplace learning represents a significant such opportunity, with job characteristics playing a pivotal role in enabling learning processes (Cerasoli et al., 2018; Wielenga-Meijer et al., 2010). Learning-related task characteristics consist of a combination of task identity (complete tasks), job autonomy, skill variety, and feedback (Hacker, 2003; Richter & Wardanjan, 2000). The concept of learning-related task characteristics is based on action regulation theory (Frese & Zapf, 1994), which emphasizes the importance of task resources for action regulation (Zacher & Frese, 2018). Action regulation theory predicts various positive consequences if job tasks require action regulation: For instance, such requirements should stimulate cognitive-motivational processes, the development of knowledge and skills, and further personality development (Hacker, 2003; Frese & Zapf, 1994; Zacher & Frese, 2018).

Action regulation theory further stresses the combination of task characteristics that should create favorable conditions for learning at work. Here, the completeness of the action process is crucial for learning. A complete process involves stages of goal setting, orientation, plan development, decision making, execution, monitoring, and feedback (Frese & Zapf,

1994). The few studies to date on learning-related task characteristics confirm positive relationships with work motivation, self-efficacy, work ability (Bergmann et al., 2009; Richter, 2010), and job satisfaction (Spieß et al., 2007). Moreover, various job design approaches address the importance of task characteristics for motivational, cognitive, and learning processes at work (Bakker & Demerouti, 2017; Hackman & Oldham, 1976). Specifically, Parker's (2017) recent work design growth model explicitly specifies the particular significance of job resources (e.g., job autonomy, task identity) to support informal learning, and cognitive and motivational processes. Thus, in line with action regulation theory (Frese & Zapf, 1994) and SST (Carstensen et al., 1999), we propose that learning-related task characteristics evoke cognitive-motivational and growth-related processes (Wielenga-Meijer et al., 2010; Zacher & Frese, 2018) that activate knowledge-related goals and increase OFTP.

Hypothesis 1: Learning-related task characteristics positively affect OFTP.

5.2.2 Occupational Self-Efficacy and Occupational Future Time Perspective

Occupational self-efficacy concerns the domain-specific self-efficacy and is defined as "the competence that a person feels concerning the ability to successfully fulfill the tasks involved in his or her job" (Rigotti et al., 2008; p. 239). The construct is based on social cognitive theory (Bandura, 1986) and takes an agentic perspective toward human development, acknowledging individuals as proactive, self-reflecting, and self-regulating. Research confirms positive relationships of occupational self-efficacy with attitudinal outcomes (e.g., job satisfaction or commitment) and negative relationships with job insecurity and neuroticism (Rigotti et al., 2008; Schyns & von Collani, 2002). In addition, individuals with high levels of general self-efficacy have a more extended general FTP (Kooij et al., 2018; Park & Jung, 2015). In our study, we examine the relationship between occupational self-efficacy and OFTP. We base our hypothesis on social cognitive theory (Bandura, 1986) and SST (Carstensen et al., 1999), because beliefs about one's (occupational) efficacy comprise motivation, goal orientation, and thought patterns that tend to be either self-

enhancing or self-hindering (Bandura, 1989). As individuals with high self-efficacy perceive difficult tasks as challenges to be mastered and engage in more adaptive behaviors to achieve these goals (Bandura, 1989), we expect that OFTP is positively affected by occupational self-efficacy.

Hypothesis 2: Occupational self-efficacy positively affects OFTP.

5.3 Job Crafting as an Underlying Mechanism

Job crafting is defined as „the physical and cognitive changes individuals make in the task or relational boundaries of their work." (Wrzesniewski & Dutton, 2001, p. 179). It is an individual, proactive approach to job redesign to increase employees' individual person–environment fit and a self-regulation adjustment process for successful development within working life (Beier et al., 2022; Kooij et al., 2015). Not surprisingly, Kooij et al. (2020) conceive job crafting as a self-regulation behavior that is a central mechanism for successful aging at work.

Tims et al. (2012) developed the widely accepted resource-based perspective of job crafting, proposing that employees craft their jobs by increasing structural and social job resources, increasing challenging job demands, and decreasing hindering job demands. Recent research further specified that these strategies are determined by employees' regulatory focus (Rudolph et al., 2017; Lichtenthaler & Fischbach, 2018a). Regulatory focus theory (Higgins, 1997) refers to two independent motivational principles of self-regulation. Promotion-focused activities are motivated by growth and development needs and are sensitive to positive outcomes. In contrast, prevention-focused behaviors aim at fulfilling security needs and are characterized by a high sensitivity to negative outcomes. Correspondingly, promotion-focused job crafting comprises increasing challenging job demands and structural and social job resources. In addition, prevention-focused job crafting refers to avoidance motives focusing on decreasing hindering demands (Lazazzara et al., 2020; Zhang & Parker, 2019).

Although job crafting is seen generally as a vehicle to improve the person–

environment fit and well-being at work (Xin et al., 2024), research emphasizes differential effects of both job crafting strategies. While promotion-focused job crafting is positively associated with work engagement and performance and negatively with burnout, prevention-focused job crafting shows negative associations with work engagement and performance and positive associations with burnout (Lichtenthaler & Fischbach, 2018a). Accordingly, prevention-focused job crafting is considered less functional, however, its mechanisms are not well understood (Rudolph et al., 2017; Zhang & Parker, 2019). Whether individuals regulate themselves predominantly in promotion- or prevention-focused ways depends on situational and personal factors (Brockner & Higgins, 2001). In accordance with this broad theoretical notion, we link learning-related task characteristics and occupational self-efficacy with both job crafting strategies in our research model.

5.3.1 Learning-Related Task Characteristics and Job Crafting

Learning-related task characteristics enable employees to deal with action regulation requirements, change their work environment, and adapt to person–environment misfits (Frese & Zapf, 1994; Zacher et al., 2016). Although research has demonstrated positive associations between job crafting and single job characteristics, including job autonomy, job complexity (Rudolph et al., 2017), task identity (Kim & Lee, 2015), feedback (Gordon et al., 2015), and skill utilization (Zhang & Parker, 2019), the relationship between learning-related task characteristics and job crafting has yet to be investigated. In line with action regulation theory (Frese & Zapf, 1994) and regulatory focus theory (Higgins, 1997), we assume that learning-related task characteristics will increase attention to personal development goals and approach motives for promotion-focused job crafting on the one hand and will reduce attention to avoidance goals and thus prevention-focused job crafting on the other hand. Therefore, we hypothesize:

Hypothesis 3a: Learning-related task characteristics positively affect promotion-focused job crafting.

Hypothesis 3b: Learning-related task characteristics negatively affect prevention focused job crafting.

5.3.2 Occupational Self-Efficacy and Job Crafting

Occupational self-efficacy determines which goals employees set, which challenges they undertake, and how much effort they exert (Bandura, 1989; Schyns & von Collani, 2002). Therefore, work design models propose that self-efficacy is an individual resource that can evoke job crafting (Bakker & Demerouti, 2017). Empirical studies support this assumption and demonstrate positive associations of general self-efficacy and promotion-focused job crafting and negative associations with prevention-focused job crafting (Rudolph et al., 2017; Tims et al., 2012). In line with social cognitive theory (Bandura, 1986) and regulatory focus theory (Higgins, 1997), we assume that employees with high levels of self-efficacy are focused on growth and aspirations, while employees with low levels of self-efficacy are focused on safety. Therefore, we propose the following:

Hypothesis 4a: Occupational self-efficacy positively affects promotion-focused job crafting.

Hypothesis 4b: Occupational self-efficacy negatively affects prevention-focused job crafting.

5.3.3 Job Crafting as a Mediator Variable

According to the process model of successful aging at work (Kooij et al., 2020), job crafting is a self-regulation process, which mediates associations between job factors, personal factors, and successful aging at work and entails strategies to maintain, adjust, and restore the individual person–environment fit. Regarding the proposed effects of job crafting strategies on OFTP, we argue in line with regulatory focus theory (Higgins, 1997) and SST (Carstensen et al., 1999) that job crafting affects the cognitive appraisal of time. Specifically, promotion-focused job crafting aims at growth and development needs and evokes a motivational process, which allows employees to approach positive conditions and focus on

work-related gains (Bakker & Demerouti, 2017; Higgins, 1997). Similarly, high priority on growth, challenges, and knowledge-related goals are also characteristics of high levels of OFTP (Carstensen et al., 1999). Initial empirical findings demonstrate positive effects of a promotion focus on open-ended FTP (Zacher & De Lange, 2011) and of promotion-focused job crafting on OFTP (Zacher & Rudolph, 2019). Thus, in line with Hypotheses 3a and 4a, which draw upon action regulation theory and social cognitive theory and assume a positive association between learning-related task characteristics and occupational self-efficacy with promotion-focused job crafting, we put forward the following:

Hypothesis 5a: Learning-related task characteristics affect OFTP indirectly and positively via promotion-focused job crafting.

Hypothesis 5b: Occupational self-efficacy affects OFTP indirectly and positively via promotion-focused job crafting.

Prevention-focused job crafting aims at addressing security needs and avoiding negative states (Higgins, 1997) by decreasing hindering job demands. This disengaging approach limits opportunities for mastery experiences and personal growth and is related to low motivation at work (Petrou et al., 2018). Similarly, the high importance of short-term goals and emotion regulation instead of growth motives are also characteristics of low levels of OFTP (Carstensen et al., 1999). In terms of empirical findings, Zacher and De Lange (2011) reported a positive effect of prevention focus on limited FTP. Regarding prevention-focused job crafting, research confirmed that it is less successful than promotion-focused job crafting because job demands are less likely to be changed than job resources (Hakanen et al., 2006; Tims et al., 2013). This is more likely to evoke negative affective responses (Weiss & Cropanzano, 1996) and may render work less meaningful, manageable, and understandable (Lichtenthaler & Fischbach, 2016a). Thus, in line with Hypotheses 3b and 4b, which draw upon action regulation theory and social cognitive theory and assume a negative association between learning-related task characteristics and occupational self-efficacy with prevention-

focused job crafting, we propose the following:

Hypothesis 6a: Learning-related task characteristics affect OFTP indirectly and negatively via prevention-focused job crafting.

Hypothesis 6b: Occupational self-efficacy affects OFTP indirectly and negatively via prevention-focused job crafting.

5.3.4 Considerations of Other Directions

As previously stated, in our theoretical model, we consider learning-related task characteristics and occupational self-efficacy as predictors, job crafting behaviors as mediators, and OFTP as the outcome of the process. This is in line with research results that confirmed OFTP as a criterion variable (e.g., Zacher & De Lange, 2011; Zacher & Frese, 2009; Weiss et al., 2016). However, pertinent theoretical perspectives view (O)FTP mainly as a predictor variable and therefore as a personal resource for successful aging at work (e.g., Carstensen et al., 1999; Kooij et al., 2020, 2018). Subsequently, the effects we postulate in our hypotheses may also be reversed (i.e., starting with OFTP as predictor variable) for the following reasons.

First, SST (Carstensen et al., 1999) proposes that FTP shapes employees' cognition, emotion, motivation, and behavior. It is therefore conceivable that OFTP could trigger job crafting behavior. Because employees with high levels of OFTP strive for growth, challenges, and knowledge-related goals, promotion-focused job crafting could be an appropriate vehicle to achieve these goals. On the other hand, employees with low levels of OFTP strive to regulate negative emotions, focus on preserving losses, and reduce hindering job demands. Therefore, prevention-focused job crafting could be a strategy to achieve this. Accordingly, OFTP could initiate job crafting behavior as some studies confirmed (Hu et al., 2020; Zacher & Rudolph, 2019).

Second and based on the resource-based perspective of job crafting (Tims et al., 2012), job crafting activities are directed at changing job characteristics. In terms of resources,

research confirmed that job crafting activities can efficiently increase structural and social resources at work (Tims et al., 2013). Therefore, promotion-focused job crafting may strengthen learning-related task characteristics. Third and consistent with social cognitive theory (Bandura, 1986), job crafting behavior could also shape occupational self-efficacy as the theory proposes mastery experiences, vicarious experiences, social persuasion, and physiological states as sources of self-efficacy. Therefore, proactive job crafting activities directed at enhancing person–environment fit could strengthen employees' beliefs in their capacity to achieve relevant goals. In sum, there are reasons to assume that alternative time-lagged directions may apply. Therefore, we realized a study design that allows us to test our hypotheses and also explore the reversed direction of effects as outlined above.

5.4 Method

5.4.1 Participants and Procedure

Participants of different organizations were recruited as part of a more comprehensive data set of the German Federal Institute for Occupational Safety and Health (BAuA; https://www.baua.de/EN; project F2372; data will be shared on request to the corresponding author with permission of BAuA). Employees completed the online questionnaire on two occasions with an average interval of eleven months between T1 and T2 (the time lag was between nine and 12 months). This is in line with studies that have studied similar constructs (e.g., Kooij et al., 2017a) and with recommendations for more complex investigations (e.g., reciprocal research questions, Dormann & Griffin, 2015).

Human resource managers in the participating organizations invited employees to complete the questionnaire via e-mail. In the first wave, 656 employees followed the link to the questionnaire, and 551 participants could be included in the analyses (drop-out rate 16%). In the second wave, 380 employees followed the link, and 349 participants could be included in the analyses (drop-out rate 8%). Of these participants, 184 completed the first questionnaire on the first occasion. One reason for the relatively high drop-out rate between the two

measurement times could be that we had to rely on third persons (i.e. organizational multipliers) to recruit respondents within the organizations and we did not pay employees for participation. Furthermore, the self-selected code for the matching process probably resulted in errors over a time lag of eleven months in some cases, which meant that the two completed questionnaires by a respondent could not be matched successfully via the individual code. The total sample of 184 employees (67.4 % female; 32.6% male) stemmed from eleven organizations in Germany (76.1% local government; 17.4% banking and insurance; 6.5% other service organizations). Participants ranged in age from 22 to 62 years with a mean age of 43.4 years (SD = 11.15). In terms of achieved educational level, 43.2% had a professional qualification and 56.8% a college or university degree. The vast majority worked full time (i.e., > 35 hours per week; 82.5%) and had a permanent contract (95.6%).

Table 11

Means, standard deviations, and intercorrelations among study variables

	M	*SD*	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Age	43.42	11.15	-												
2. Gender	1.33	0.47	.13	-											
3. Health	7.15	1.83	-.12	.08	-										
4. LRTC (T1)	4.95	0.80	.09	.07	.13	(.90)									
5. OSE (T1)	5.27	0.95	.22**	.16*	.27**	.36**	(.86)								
6. PROM-JC (T1)	4.57	0.90	-.17*	-.08	.27**	.53**	.36**	(.87)							
7. PREV-JC (T1)	2.77	1.07	-.11	.04	-.04	-.18**	-.24**	-.10	(.81)						
8. OFTP (T1)	3.65	1.42	-.73**	-.01	.23**	.17*	.00	.40**	.09	(.86)					
9. LRJC (T2)	5.02	0.73	.14	.12	.15*	.64**	.31*	.47**	-.05	.18*	(.89)				
10. OSE (T2)	5.27	0.89	.17*	.17*	.17*	.28**	.70**	.21**	-.17*	.04	.38**	(.86)			
11. PROM-JC (T2)	4.56	0.93	-.21**	-.02	.25**	.45**	.26**	.72**	.01	.43**	.56**	.28**	(.88)		
12. PREV-JC (T2)	2.90	1.11	.00	-.01	-.13	-.02	-.22**	-.04	.63**	-.07	-.06	-.21*	-.04	(.83)	
13. OFTP (T2)	3.62	1.46	-.74**	-.06	.15*	.10	.01	.29**	.07	.84**	.19*	.09	.40**	-.05	(.87)

Note. N = 184 at Time 1 and Time 2. Reliabilities (Cronbach's alpha) are shown in parentheses on the diagonal. Abbreviations: T = time; LRJC = Learning-related task characteristics; OSE = Occupational self-efficacy; PROM-JC = Promotion-focused job crafting; PREV-JC = Prevention-focused job crafting; OFTP = Occupational future time perspective. *$p < .05$, **$p < .01$.

5.4.2 Measures

All items were measured on 7-point Likert scales (1 = “does not apply at all” to 7 = “fully applies”). All variables were measured at both times. Cronbach’s alphas of all scales were adequate across measurement occasions (see Table 11), and confirmatory factor analyses confirm that the scales showed sufficient psychometric quality.

Learning-related Task Characteristics. We used the questionnaire on learning-related characteristics of the work task (FLMA, Fragebogen zu lernrelevaten Merkmalen der Arbeitsaufgabe [questionnaire to assess learning-related task characteristics]; Richter & Wardanjan , 2000) to measure learning-related task characteristics comprising task identity and autonomy (e.g., “I can determine the order of the work steps in my job myself.”, “I carry out, plan, coordinate, and check my work.”; 12 items), skill variety (e.g., “My work requires a variety of skills and abilities.”; 7 items) and feedback (e.g., “My superiors and/or colleagues tell me whether they are satisfied or dissatisfied with my work.”; 5 items). Similar to the validation study (Richter & Wardanjan, 2000), the internal consistency of all 24 items was 0.90 (T1) and 0.89 (T2) respectively. The authors argued that high values justify the formation of a total value of learning-related task characteristics as a whole. For evaluating confirmatory factor analyses (and later overall model fits), we follow conventional guidelines, using χ^2/df to be close to or less than 5, the comparative fit index (CFI) to be close to or greater than .95 for a good model fit, and standardized root mean square residual (SRMR) to be close to or less than .08 (West et al., 2012). We also report rootmean square error of approximation (RMSEA) that is aimed at being close to or less than .06. However, we do not consider RMSEA for detailed interpretation because it is not considered to be a reliable fit index for small sample sizes (West et al., 2012). For learning-related task characteristics, a confirmatory factor analysis with some modifications (e.g., certain items within a subscale were allowed to correlate) showed a satisfactory model fit (χ2[232] = 346.55; RMSEA = 0.05, CFI = 0.93, SRMR = 0.06).

Occupational Self-Efficacy. We used the six-item short version of the German occupational self-efficacy scale (Rigotti et al., 2008) to measure occupational self-efficacy (e.g., “I feel prepared for most of the demands in my job.”; six items). A confirmatory factor analysis revealed a satisfactory model fit ($\chi 2[7] = 9.38$; RMSEA = 0.04, CFI = 0.99, SRMR = 0.02).

Job Crafting. Job crafting was measured with the German version (Lichtenthaler & Fischbach, 2016b) of the job crafting scale by Tims et al. (2012). Promotion-focused job crafting was measured with 15 items reflecting increasing structural job resources (e.g., “I try to develop my capabilities.’; five items), increasing social job resources (e.g., “I ask others for feedback on my job performance.”; five items), and increasing challenging job demands (e.g., “If there are new developments, I am one of the first to learn about them and try them out.”; five items). Prevention-focused job crafting was measured with six items reflecting decreasing hindering job demands (e.g., “I try to ensure that I do not have to make many difficult decisions at work.”). A confirmatory factor analysis revealed satisfactory model fit for the dimension of promotion-focused job crafting ($\chi 2[85] = 183.15$; RMSEA = 0.08, CFI = 0.92, SRMR = 0.06) and for prevention-focused job crafting ($\chi 2[7] = 22{,}96$; RMSEA = 0.11, CFI = 0.97, SRMR = 0.05).

OFTP. We used Zacher and Frese’s (2009) six-item OFTP Scale comprising perceived remaining opportunities (e.g., “Many opportunities await me in my occupational future.”; three items) and perceived remaining time (e.g., “Most of my occupational life lies ahead of me.”; three items). A confirmatory factor analysis revealed a satisfactory model fit ($\chi 2[7] = 20.16$; RMSEA = 0.10, CFI = 0.99, SRMR = 0.02)

Control Variables. We controlled for chronological age, gender, and general health because previous research has shown these variables are related with job crafting behavior (e.g., Kooij et al., 2017b, Lichtenthaler & Fischbach, 2018b; Rudolph et al., 2017) and OFTP (e.g., Henry et al., 2017; Rudolph et al., 2018). At T1, we assessed chronological age and

gender (1 = “female”, 2 = “male”) by a single item as well as general health (“If you assign a score of 10 to the best conceivable state of health and a score of 0 to the worst conceivable state of health, how many points would you assign for your current state of health?”; based on the German version of the work ability index; Hasselhorn & Freude, 2007).

5.4.3 Analysis Strategy

We tested our pre-registered hypotheses (osf.io/5fg42) by analyzing our data using Mplus 8.7 and relying on maximum likelihood estimation (all deviations from our preregistration can be found in Appendix D). We follow Cole and Maxwell’s (2003) approach to test mediated effects in time-lagged research including independent, mediating, and outcome variables, each measured at both times. The time-lagged indirect effect model allowed us to test our hypotheses simultaneously (Preacher & Hayes, 2008). Our proposed model consists of two predictors (i.e., learning-related task characteristics, occupational self-efficacy), two parallel mediators (i.e., promotion- and prevention-focused job crafting), and one outcome variable (i.e., OFTP). Due to the power limitations (i.e., large number of parameters to be estimated compared to the sample size), we decided to simplify the specification of our proposed model (i.e., number of freely estimated parameters) and use aggregated observed variables (i.e., mean scores) to represent the variables (cf. Petrou et al., 2018).

We examined common method variance at both measurement occasions because all measures were self-reported. The explained variances for a single factor did not indicate a significant impact in our data (20.07% at T1 and 20.14% at T2; Podsakoff et al., 2003), thereby lessening concerns about common method variance influencing our findings.

Our data analysis is based on the approach proposed by Cole and Maxwell’s (2003) for testing mediation models in studies with a two-wave design. Within data analyses, it is not commonly accepted that the mediator variable coincides in time with either the predictor or the outcome variable. However, there is a risk of bias in this case because this “half-

longitudinal" design does not allow for the control of prior levels of the mediator. To avoid this and assuming stationarity in our two waves, we included additional paths in our model to be estimated. These include one path in the regression of job crafting as the mediator variable (measured at T2) onto the predictor variables learning-related task characteristics and occupational self-efficacy (T1) while controlling for job crafting at T1, and another path in the regression of the outcome variable OFTP (T2) onto job crafting at T1 while controlling for OFTP at T1 (Cole & Maxwell, 2003).

In addition to considering the described temporal characteristic of the mediator variable, our modelling procedure included the estimation of additional competing time-lagged path models to test the order of our variables of interest and to explicate the processes (Selig & Preacher, 2009; Zapf et al., 1996). Here, we focus on our proposed hypotheses. However, as previously mentioned, there are also reasons to assume the reversed direction. Therefore, we test four mediational models using time-lagged data, which enables us to test both our hypotheses and reversed effects (Cole & Maxwell, 2003).

The baseline, or stability model (M0), comprises autoregressive paths that minimize bias in the estimation of cross-lagged effects (Selig & Little, 2012). It includes covariances of the focal variables within each measurement time and across measurement occasions. In this instance, each dependent variable included the statistical control for prior levels of the same variable. The causality model (M1) referred to our hypotheses and added regression paths while controlling for stability effects: Job crafting behaviors (T2) were regressed onto learning-related task characteristics and occupational self-efficacy (T1), while controlling for job crafting behaviors (T1), and OFTP (T2) was regressed onto the mediators (promotion- and prevention-focused job crafting, T1) while controlling for OFTP (T1). The reversed model (M2) tested effects in the opposite direction, while the reciprocal model (M3) combined M1 and M2 and considered both directions simultaneously.

Although the causality model and the reversed model are not hierarchically related to

each other, they are nested within the reciprocal model that enables a model comparison via χ^2-difference tests (Cole & Maxwell, 2003). We used bias-corrected bootstrapping with 5.000 bootstrap samples to estimate model parameters and 95% confidence intervals for regression weights to test for indirect effects (Preacher & Hayes, 2008). For all models, we report standardized coefficients.

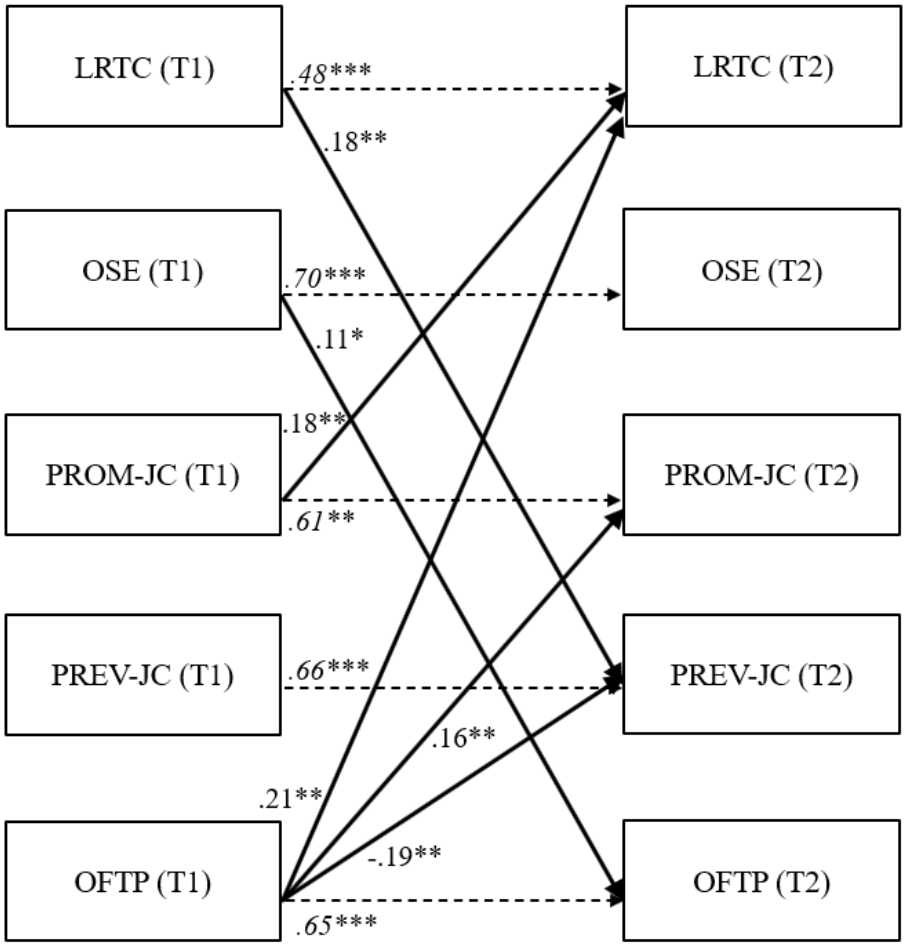
5.5 Results

5.5.1 Descriptive Statistics

Table 11 presents all variables' means, standard deviations, and bivariate correlations. Correlational analyses indicate that learning-related task characteristics are positively correlated across the different measurement times with OFTP. However, associations between occupational self-efficacy and OFTP were non-significant. Learning-related task characteristics and occupational self-efficacy are positively related to promotion-focused job crafting and not related or negatively related to prevention-focused job crafting. Additionally, promotion-focused job crafting was positively associated with OFTP, whereas prevention-focused job crafting was not. The intercorrelations between T1 and T2 of all observed variables are highest for OFTP ($r = .84$).

Figure 6

Mediation model results for learning-related task characteristics, occupational self-efficacy, occupational future time perspective, and promotion-focused job crafting and prevention-focused job crafting as mediators



Note. For the sake of clarity, only significant cross-lagged paths (bold lines) and autoregressive paths (dashed lines, italics) are presented. Control variables were included.

The predictor variables explained 46% of the variance in T2 learning-related task characteristics (LRTC), 49% of the variance in T2 occupational self-efficacy (OSE), 55% of the variance in promotion-focused job crafting (PROM-JC), 45% of the variance in T2 prevention-focused job crafting (PREV-JC), and 75% of the variance in T2 occupational future time perspective (OFTP). *$p < .05$, **$p < .01$, ***$p < .001$.

5.5.2 Testing the Proposed Model

We examined the estimation of the models sequentially. Figure 6 shows that the stability model (M0) has statistically significant autoregressive effects between T1 and T2, indicating stability of interindividual differences in the investigated variables. The causality model (M1) includes additional crossed-lagged paths from T1 predictors (learning-related task characteristics, occupational self-efficacy) to T2 mediators (job crafting behaviors), T1 predictors and T2 outcomes (OFTP), and T1 mediators to T2 outcomes. M1 demonstrates an acceptable fit, significantly better than M0 (see Table 12). We conducted additional analyses on reversed effects (reversed model, M2) to confirm the direction of the associations and to rule out opposing directions. M2 involves promotion- and prevention-focused job crafting as mediators in the relationship between OFTP at T1 and both learning-related task characteristics and occupational self-efficacy at T2. This model also fits significantly better to the data than M0. Finally, the reciprocal model (M3) includes a combination of M1 and M2 and showed a good fit to the data, significantly better than the other models ($\chi^2[4] = 3.32$, $p = .51$; CFI = 1.00; RMSEA = 0.00, 90 % CI = [0.000, 0.103]; SRMR = 0.01). Therefore, we refer to M3 as the best fitting model to test our hypotheses (see Table 12). Table 13 presents the cross-lagged model estimates of the final reciprocal model.

Table 12

Summary of model fit indices

Model description	χ^2	*df*	χ^2/df	CFI	RMSEA	SRMR	Comparison	Δdf	$\Delta\chi^2$
M0 Stability model	50.02	20	2.50	0.96	0.09	0.05			
M1 Causality model	28.05	12	2.34	0.98	0.09	0.03	M1 vs. M0	8	21.97**
M2 Reversed model	23.51	12	1.96	0.99	0.07	0.03	M2 vs. M0	8	26.51***
M3 Reciprocal model	3.32	4	0.83	1.00	0.00	0.01	M3 vs. M0	16	46.70***
							M3 vs. M1	8	24.73**
							M3 vs. M2	8	20.19**

Note. N = 184. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square. Control variables were included. ** $p < .01$, *** $p < .001$.

Regarding the main effects, learning-related task characteristics did not show a positive lagged effect on OFTP (β = 0.03, 95% CI [–0.06, 0.12], p = 0.51), thereby not supporting Hypothesis 1. However, we found a significant lagged effect of occupational self-efficacy on OFTP (β = 0.11, 95% CI [0.02, 0.20], p = 0.013), as assumed by Hypothesis 2. We did not find a significant lagged effect of learning-related task characteristics on promotion-focused job crafting (i.e., no support for Hypothesis 3a; β = 0.09, 95% CI [–0.04, 0.24], p = 0.11), but a significant, however negative lagged effect of learning-related task characteristics on prevention-focused job crafting (i.e., no support for Hypothesis 3b; (β = 0.18, 95% CI [0.06, 0.31], p = 0.003). With regard to occupational self-efficacy, we neither found a lagged effect on promotion-focused job crafting (β = –0.01, 95% CI [–0.13, 0.10], p = 0.83) nor on prevention-focused job crafting (β = –0.09, 95% CI [–0.22, 0.04], p = 0.15), which provides no support for Hypotheses 4a and 4b. As we did not observe any effects of job crafting behaviors on OFTP, indirect effects are absent. This means that Hypotheses 5a, 5b, 6a, and 6b are not empirically supported.

Table 13

Summary of cross-lagged model estimates of the causality model, reversed model and reciprocal model

Estimate	Causality model (M1)	Reversed model (M2)	Reciprocal model (M3)
Stabilities			
LRTC	0.56***	0.50***	0.48***
OSE	0.64***	0.69***	0.70***
PROM-JC	0.60***	0.65***	0.61***
PREV-JC	0.67***	0.64***	0.66***
OFTP	0.62***	0.66***	0.65***
Cross-lagged effects of LRTC			
LRTC → OFTP	0.097		0.030
LRTC → PROM-JC	0.148*		0.094
LRTC → PREV-JC	0.144*		0.184**
Cross-lagged effects of OSE			
OSE → OFTP	0.166*		0.108*
OSE → PROM-JC	-0.012		-0.011
OSE → PREV-JC	-0.097		-0.092
Cross-lagged effects of PROM-JC			
PROM-JC → OFTP	-0.121		-0.049
PROM-JC → LRTC		0.203**	0.184**
PROM-JC → OSE		-0.066	-0.075
Cross-lagged effects of PREV-JC			
PREV-JC → OFTP	-0.018		-0.010
PREV -JC → LRTC		0.049	0.038
PREV -JC → OSE		-0.021	-0.026
Cross-lagged effects of OFTP			
OFTP → LRTC		0.217*	0.214*
OFTP → OSE		0.148	0.151
OFTP → PROM-JC		0.180*	0.163*
OFTP → PREV-JC		-0.120	-0.186*
Model fit			
χ^2/df	2.34	1.96	0.83
CFI	0.98	0.99	1.00
RMSEA [90 % CI]	0.09 [0.044, 0.127]	0.07 [0.026, 0.115]	0.00 [0.00, 0.103]
SRMR	0.03	0.03	0.01

Note. $N = 184$. LRJC = Learning-related task characteristics; OSE = Occupational self-efficacy; PROM-JC = Promotion-focused job crafting; PREV-JC = Prevention-focused job crafting; OFTP = Occupational future time perspective. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square. Standardized parameter estimates are presented. Control variables were included. * $p < .05$, ** $p < .01$, *** $p < .001$.

In addition to testing our proposed model, we conducted exploratory analyses, referring to the final reciprocal model. We found significant lagged effects of OFTP on learning-related task characteristics (β = 0.21, 95% CI [0.01, 0.40], p = 0.015), on promotion-focused job crafting (β = 0.16, 95% CI [0.01, 0.34], p = 0.044) and on prevention-focused job crafting (β = –0.19, 95% CI [-0.37, -0.01], p = 0.037). Consequently, we tested indirect lagged effects of OFTP on learning-related task characteristics via promotion-focused job crafting. We used 5,000 bootstrap samples to construct 95% CIs to determine whether the contribution of promotion-focused job crafting was significantly different from zero. The indirect effect was statistically significant and positive (indirect effect = 0.16, SE = .04, 95% CI [0.01, 0.16]), with zero not included in the interval. Finally, we identified a lagged effect from promotion-focused job crafting on learning-related task characteristics (β = 0.18, 95% CI [0.03, 0.36], p = 0.007).

Table 13 presents the final reciprocal model (M3). Estimates of the causality model (M1) and the reversed model (M2) differ marginally from the estimates of the reciprocal model, indicating the robustness of the results.

5.6 Discussion

In the present article, we investigated the relationships between learning-related task characteristics, occupational self-efficacy, job crafting behavior, and OFTP. Within our cross-lagged panel design, we analyzed also potential reversed and reciprocal relationships of these variables to specify the role of OFTP within the context of successful aging at work. Our findings first highlight the malleability of OFTP via the personal resource of occupational self-efficacy. Consistent with previous research (see Park & Jung, 2015), these self-enhancing thought patterns support employees' reflections of their future time at work. Second, and contrary to our expectations, learning-related task characteristics do not act as a job-related antecedent of OFTP stimulating cognitive growth processes. Furthermore, learning-related task characteristics do not initiate job crafting behaviors that stimulate OFTP in a positive

manner later on.

Our exploratory analyses rather indicate reversed findings. They revealed that OFTP strengthens learning-related task characteristics directly and indirectly via promotion-focused job crafting. Employees with high levels of OFTP are more engaged in promotion-focused job crafting (i.e., in line with development-related goals) compared to employees with a constrained OFTP. Conversely, OFTP affects preventions-focused job crafting negatively. Therefore, employees who perceive their occupational time as limited are more engaged in prevention-focused job crafting (i.e., in line with emotion-related goals), which is considered dysfunctional (Lichtenthaler & Fischbach, 2016a). These findings indicate OFTP as a personal resource for job crafting, which is conceptualized as a central self-regulatory process for successful aging at work (Kooij et al., 2017a; 2020).

One potential explanation for the lacking impact of learning-related task characteristics on OFTP may be that OFTP represents a rather stable motivational construct that is not significantly affected by work-related factors within our time lag of eleven months (Dormann & Griffin, 2015; Selig & Little, 2012). It is also possible to view learning-related task characteristics not only as a work-related resource, but also as a hindering job demand, depending on the employees' personal resources (Parker, 2017). This is consistent with a third central outcome of our study, namely the finding that learning-related task characteristics initiate prevention-focused job crafting. Despite our expectations, the study's findings show that learning-related task characteristics do not reduce the focus on avoidance goals (i.e., prevention-focused job crafting; Higgins, 1997). Instead, they seem to increase attention to these goals. This aligns with ideas about the ambivalence of job resources (e.g., Dettmers & Bredehöft, 2020).

Overall, the findings of our study indicate that associations are more complex than we assumed and that OFTP is not as malleable as expected. Specifically, it is not affected by learning-related task characteristics or by job crafting strategies. Instead, a pronounced OFTP

results in employees engaging in job crafting behavior to change the work environment, which in turn is likely to lead to successful aging at work (Kooij et al., 2020). Consequently, our findings suggest that a pronounced OFTP may not be a direct indicator of successful aging at work. Rather, it appears to be an individual resource for successful aging that is influenced by a more stable personal resource (i.e., occupational self-efficacy). By specifying the direction of the effects within our reciprocal model, we make a significant contribution to the role of OFTP in the context of aging at work. Therefore, our research contributes to theoretical approaches of successful aging at work and practical implications for organizations may also be derived from these findings.

5.6.1 Theoretical Implications

Firstly, we integrated lifespan developmental perspectives with organizational theories and clarified mechanisms between OFTP and job crafting behaviors. Some studies proposed and found effects from (O)FTP on job crafting (Hu et al., 2020; Kooij et al., 2017a) while only a few have investigated the opposite direction (Taneva & Peng, 2023; Zacher & Rudolph, 2019). To the best of our knowledge, our study is the first to consider both directions simultaneously and explore the prevailing order of the constructs. Our time-lagged reciprocal model could demonstrate that OFTP affects job crafting, and not the other way round. These findings accord with SST (Carstensen et al., 1999), which assumes that goal shifts depend on time perceptions. Thus, our study specified that OFTP determines whether self-regulation behavior is either aligned with developmental objectives and a promotion focus, or with emotion-related goals and a prevention focus. With regard to SST, it can be concluded that OFTP not only affects individual goals, but also initiates modifications to task characteristics through the process of job crafting. Furthermore, we could demonstrate OFTP‘s malleability only in terms of occupational self-efficacy (i.e., a personal characteristic). It did not appear to be readily modified by job design characteristics or proactive strategies for redesigning jobs, such as job crafting. In terms of the process model of

successful aging at work (Kooij et al., 2020), OFTP should be therefore acknowledged as a personal antecedent for the self-regulation process aiming at successful aging rather than the outcome of the process.

Secondly, our study contributes to theories of job design and aging because we incorporated learning-related task characteristics in our research and went "beyond the classic constructs of workload and job control" (Decius et al., 2023b, p. 17). In line with action regulation theory (Frese & Zapf, 1994), we expected that learning-related task characteristics affect job crafting behavior and, in turn, OFTP. However, we found that learning-related task characteristics are not powerful enough to initiate promotion-focused job crafting or OFTP positively. Rather, it is OFTP that initiates promotion-focused job crafting which strengthens learning-related task characteristics in turn. Therefore, compared to employees who perceive their OFTP as limited, employees with an open OFTP are more active in designing learning-related task characteristics and enriching their work environment. This is consistent with research that stresses the incorporation of OFTP for stimulating workplace learning (Kooij & Zacher, 2016) and learning motivational beliefs among employees (Kochoian et al., 2017). Therefore, OFTP as a personal and age-related resource should be considered in work design models. In view of action regulation theory (Frese & Zapf, 1994), it can be stated that task characteristics are not the only factor influencing work-related learning and personal development. Furthermore, personal characteristics (i.e., OFTP) initiate proactive behavior that strengthens learning-related task characteristics. Consequently, our findings reinforce the theory's assumption that employees are active agents who can influence the (working) conditions of their personal development (Zacher et al., 2016).

5.6.2 Practical Implications

The findings of our study also have implications for practitioners seeking to promote successful aging at work. First, organizations are encouraged to implement measures to promote successful aging at work, encompassing individual, team-related, and organizational

interventions. As we found occupational self-efficacy to be a predictor for OFTP, organizations and human resource managers are encouraged to support employees in aging successfully by promoting personal resources for career development and work ability (Pak et al., 2019). Possibilities to develop a strong sense of self-efficacy consist of mastery, feedback (Bandura, 1989), and more specifically supervisor behavior (e.g., leader-member exchange; Schyns & von Collani, 2002). Given that occupational self-efficacy has an impact on OFTP, organizations should be mindful of motivational shifts led by OFTP to understand age-related changes with respect to career job crafting behavior, person-environment fit, adaptability, and work ability (Cadiz et al., 2019a; Fasbender et al., 2019; Kooij et al., 2017a).

Second, learning-related task characteristics could be a promising concept within proactive behavior and successful aging at work. Although we did not find that learning-related task characteristics are a predictor of OFTP, we demonstrated that employees with an extended OFTP aim at increasing their learning-related task characteristics by promotion-focused job crafting. In today's dynamic work environment, characterized by more unstable employment and ever-changing jobs, organizations need to foster a learning orientation and continually enhance employees' capabilities and competencies (Tannenbaum, & Wolfson, 2022). Informal workplace learning is a key construct, related to and caused by task characteristics, such as learning-related task characteristics (Cerasoli et al., 2018). Therefore, organizations can gain a sustainable competitive advantage by promoting OFTP and fostering a supportive learning culture that addresses informal workplace learning (Mühlenbrock et al., 2023). However, our findings indicate that high levels of learning-related task characteristics stimulate prevention-focused job crafting, which means that employees avoid hindering job demands in the short term. This form of job crafting is regarded as a dysfunctional and disengaging approach (Zhang & Parker, 2019). Therefore, organizations should pay attention to those job characteristics that employees may perceive as extensive and hindering.

5.6.3 Limitations and Future Research Directions

In addition to the strengths of our study, we also acknowledge limitations, which could be addressed in future research. These considerations are at least threefold. In terms of conceptual understanding, there is a current lack of investigation into learning-related task characteristics. Recent research has emphasized the significance of work-related learning in relation to job crafting behavior and action regulation (e.g., Decius et al., 2023b; Parker, 2017). However, deeper insight is required to comprehend the significance of task-related learning opportunities. Investigating its measurement would help to clarify the specific combination of task characteristics that is most conducive to learning and least experienced as (overly) demanding. Furthermore, a more detailed understanding of the impact of learning-related task characteristics on prevention-focused job crafting would help to identify potential risks associated with possible excessive demands, dysfunctional work design, and counterproductive behavior. In this regard, future research could examine curvilinear effects (Cadiz et al., 2019a) and investigate the potential ambivalence of resources in terms of successful aging at work (Dettmers & Bredehöft, 2020). This is an area of significant interest in the context of digitalization and the emergence of less regulated jobs with high levels of autonomy (Karimikia et al., 2021; Schulte et al., 2020).

Another limitation of our study relates to methodological factors. Although we used multiple measures in our study, the use of self-report data alone may introduce a common methods bias (Podsakoff et al., 2003). Therefore, alternative methods to assess the constructs (e.g., job analyses, interviews, diary studies, supervisor ratings) could provide more robust conclusions on our findings. Furthermore, we measured all variables simultaneously on both occasions, assuming that the probability of detecting a change is consistent for all variables for the time interval (i.e., assumption of stationarity; Cole & Maxwell, 2003). However, the detection of an effect may differ between the constructs, depending on their stability and sensitivity to change (Dormann & Griffin, 2015). While occupational self-efficacy and job

crafting behavior are constructs that tend to be relatively malleable constructs even within a relatively short time frame, depending on personal experience and personal initiative, OFTP is probably more susceptible to change in the medium to long-term, depending on life and career phases. Using different time lags and more than two measurement waves might shed more light on the malleability of OFTP and on circumstances under which our original hypotheses may apply.

Finally, addressing analytical limitations, future research could apply structural equation modeling with latent variables and larger sample size to validate the findings and allow analyses of more complex models with factor invariance and measurement error (Selig & Little, 2012). Similarly, because our study controlled for age, future research could systematically analyze differential effects, such as whether age groups differ significantly from each other, for example in terms of job crafting behavior (Kooij et al., 2017b) or experienced stress-related consequences of resources (Yaldiz et al., 2018). In addition to age, a replication of our findings in terms of job types (e.g., blue-collar workers) and societal environments could also be relevant. Previous research has indicated potential for such effects (e.g., Decius et al., 2023b).

5.7 Conclusion

Our time-lagged study integrates job design research with a lifespan development perspective and contributes to the discourse on successful aging at work. Our findings emphasize the dual role of OFTP in both personal resource development and job crafting initiation. While occupational self-efficacy enhances OFTP as a crucial personal resource, OFTP influences job crafting behaviors rather than being influenced by them. While OFTP has a negative effect on prevention-focused job crafting, it has a positive effect on promotion-focused job crafting, which in turn enhances learning-related task characteristics. Finally, our findings suggest that learning-related task characteristics can induce prevention-focused job crafting. Overall, the insights from this study emphasize the dynamic interplay between OFTP

and job crafting, offering practical implications for fostering successful aging in the workplace.

6. Overall Discussion

This dissertation explored how work design can support successful aging and continuous informal learning at work. For this, I conducted studies from a lifespan, a learning, and an integrated perspective on work design to answer the research questions.

Regarding the first research question, Study 1 reviewed whether and how associations between psychosocial job characteristics and employee health differ across age groups. I observed age-related differences in vulnerabilities to job characteristics, but no contradictory patterns between work characteristics and health for different age groups. The second research question investigated conceptually how telework alters job characteristics and opportunities for IWL. Study 2 argues that changes occur through changing working conditions that concern social processes and role boundaries that reduce opportunities for IWL, as well as increase self-regulation demands, which enhance opportunities. Supervisor support on different levels emerged as a critical factor in strengthening IWL. The third research question investigated predictors of OFTP. Study 3 demonstrated that occupational self-efficacy is a personal resource that extended OFTP. Contrary to predictions, OFTP itself initiated job crafting and shapes learning-related task characteristics and not vice versa.

Taken together, the different perspectives on work design emphasize the importance of tailoring job characteristics to individuals' health and IWL across the lifespan. In addition to traditional organization- and supervisor-driven work design, employees' self-regulation and proactive behaviors play a crucial role in shaping their working conditions, thereby contributing continuous learning and supporting successful aging at work.

The following section synthesizes the key findings of the three studies in relation to the overarching research questions and discuss their theoretical and practical implications. Additionally, methodological and conceptual limitations of this dissertation are critically examined, providing directions for future research

6.1 Summary of Findings and Theoretical Implications

The first study of this dissertation examined interactions between psychosocial job characteristics and age with regard to employee health and provided new insights. The systematic review revealed predominantly significant interactions, and no contradictory associations were found between age groups. The findings underline the importance of well-designed working conditions for promoting employee health across all age groups, with middle-aged employees (35-49 years) identified as particularly vulnerable. For younger employees (≤ 34 years) job characteristics such as high quantitative job demands, high strain jobs, work-life conflicts, and social inclusiveness are particularly relevant for good health. For middle-aged employees, high quantitative job demands, meaningfulness, possibilities for development, and interpersonal relationships are key factors. High job autonomy, possibilities for development, and social inclusiveness are especially relevant job characteristics in view of good health for older employees (≥ 50 years). The systematic review confirms age-related developmental changes that shape associations between job characteristics and health trajectories (Kooij & Scheibe, 2024; Zacher & Froidevaux, 2021). This contributes to the advancement of work design models by incorporating a lifespan perspective to address the dynamic and evolving needs of employees when they age (Truxillo et al., 2012; Scheibe & Kooij, 2024). This perspective underscores also the value of non-linear analyses in capturing differentiated patterns across age groups, considering vulnerabilities that may otherwise remain undetected for example in linear models (Yaldiz et al., 2018; Zacher et al., 2019).

The second research question addressed job characteristics in telework settings, their impact on IWL, and how supervisors can facilitate IWL. In terms of social processes, the findings summarized in the conceptual study suggest that telework limits IWL by reducing the quantity and quality of social interactions, resulting in fewer and less rich communication cues and limited access to social support. Furthermore, telework alters self-regulation demands by increasing autonomy, particularly in time management, availability, and

managing disruptions. This facilitates IWL by offering more opportunities for experiencing and reflection. Finally, telework affects role boundary management by increasing role ambiguity and work-related and family-related disruptions. Unclear role expectations and a lack of informal learning triggers can hinder IWL. However, supervisors can support IWL via appropriately designing the work environment (e.g., promoting social exchange) and facilitating learning conditions (e.g., defining learning and availability times). Overall, telework reshapes job characteristics and therefore the infrastructure for IWL. Supervisors can adapt their support to guide employees through the modified learning infrastructure. The study highlights the relevance of the octagon model of IWL (Decius et al., 2019) in virtual work contexts and contributes to further development of IWL measures (e.g., Decius et al., 2019). IWL does not occur automatically, but supervisors can actively facilitate and shape it through designing working conditions. Moreover, the study specifies design options for promoting IWL in telework arrangement and e-leadership settings.

The third research question focused on intraindividual changes in OFTP, examining personal and task-related resources as potential predictors of OFTP with job crafting strategies as potential mediators. Findings of the two-wave study (Study 3) highlighted the dual role of OFTP – as a psychological outcome influenced by personal resources (i.e., occupational self-efficacy), and as a motivational driver of contextual resources (i.e. learning-related task-characteristics) and self-regulatory behaviors (e.g., job crafting). While occupational self-efficacy has been thus confirmed as a critical personal resource of OFTP, OFTP, in turn, affected job crafting behaviors and learning-related task characteristics rather than being influenced by them. Specifically, OFTP had a direct positive direct effect on learning-related task characteristics and an indirect effect through promotion-focused job crafting. Furthermore, the reciprocal mediation model indicates that learning-related task characteristics trigger prevention-focused job crafting but not promotion-focused job crafting enhancing OFTP. Instead, and in line with SST (Carstensen et al., 1999), OFTP initiates self-

regulation strategies (i.e., job crafting). Overall, Study 3 offered insights into the relationship between learning-related task characteristics and OFTP, thereby integrating a lifespan and learning perspective on work design and contributing to the discourse on successful aging at work (Kooij et al., 2020) by highlighting OFTP as a personal resource for successful aging and to continuous learning at work. In terms of ART (Frese & Zapf, 1994), the construct of learning-related task characteristics was examined more closely in the context of aging and proactivity, but the findings could not confirm that learning-related task characteristics initiate job crafting behavior and modify OFTP. However, the findings underline the proactive role of employees, who themselves shape their working conditions and their personal development.

Overall, the three complementary studies adopted different perspectives on work design and contributed to a better understanding of how work design can promote health, IWL, and OFTP (Table 14). The findings demonstrated age-related differences in health sensitivity to job characteristics, emphasizing the relevance of incorporating individual factors (e.g., age-related developmental changes) into theoretical models enabling age-sensitive work design (Study 1). Furthermore, the results highlighted the need for employees' self-regulation and adaptability to dynamic working conditions to maintain IWL and personal development, emphasizing also the proactive role supervisors can play in creating appropriate working conditions for learning (Study 2). Similarly, employees' self-regulation plays a central role in promoting successful aging. Drawing on OFTP, employees modify their work environment themselves to create learning-relevant conditions. Interestingly, the effects between proactive behaviors (i.e., job crafting) and job characteristics are reciprocal (Study 3).

From an overall theoretical approach, the studies demonstrate that a lifespan and learning perspective on work design covers the following key suggestions: 1) Age-related changes affect employees' action regulation; 2) combined with an additional developmental perspective on job characteristics, this foster successful aging and continuous informal learning at work; and 3) job characteristics and proactive behavior are reciprocally related.

These elements are central to the theory of action regulation across the adult lifespan (ARAL; Zacher et al., 2016). Therefore, the dissertation's results support assumptions of ARAL that employees influence, and are influenced by, their work environment across their lifespan and that characteristics of the work environment provide opportunities for learning and personality development.

Table 14

Complementary approaches of the studies

Description	Study 1	Study 2	Study 3
Perspective on work design	Lifespan perspective	Learning perspective	Integration of lifespan and learning perspective
General research question in terms of work design	How can work design help to improve employee health across the lifespan?	How can work design help to promote IWL in telework settings?	How can work design help to strengthen OFTP?
Approach of work design	Organization-driven work design (top down)	Employee- and supervisor-driven work design	Employee-driven work design (bottom-up)
Recommendation for work design	Age-sensitive work design	Learning-oriented work design	Dynamic and adaptable work design

By combining the lifespan and learning perspectives on work design, the dissertation linked job characteristics with health, IWL and OFTP, and thus identifies approaches for continuous learning and successful ageing at work. In turn, the results support prior research on continuous learning as a crucial component of successful aging at work (Wu et al., 2021). Well-designed work can stimulate learning behavior and foster opportunities for cognitive engagement (Parker et al., 2021). In turn, enhanced skills prepare employees to develop and change jobs and employers at any stage of their careers (Baraković Husić et al., 2020). Taken together, the findings suggest that high-quality work design is not only guided by organization-driven activities, but also by supervisors and employees who proactively shape

working conditions. This underlines recent research regarding shared responsibilities for learning and development (Beier et al., 2025).

6.2 Practical Implications

This dissertation offers practical implications for work design at complementary levels. At the *organizational level,* it is crucial for organizations to recognize that occupational health promotion across the lifespan and age-sensitive work design are essential for maintaining employee health (Study 1). Applying (psychosocial) risk assessment measures with an age-related focus as early as possible across the lifespan is a key strategy to prevent cumulative effects of unhealthy working conditions (Ganster & Rosen, 2013). However, a flexible work design in late career stages is significant as well, because older workers show an increased heterogeneity in needs, attitudes, and behaviors (Truxillo et al., 2015). Personal conversations with employees about these developments enable individual career trajectories, work (re)design, and healthy aging in turn (Bal, 2020; Zacher et al., 2021). Furthermore, in the context of rapidly changing work environments (e.g., due to digitalization; see Study 2), risk assessment, and the cooperation between employees, supervisors, and occupational health management help to monitor working conditions to facilitate successful aging at work. National legislation (e.g., on psychosocial risk assessment) could additionally encourage organizations to implement actions effectively (Jain et al., 2022).

At the *supervisory level*, managerial training in terms of work design, lifespan development, and continuous learning can be a key intervention to promote person–environment fit. Supervisors can directly modify working conditions (e.g., providing more autonomy) and support IWL also by accompanying learning (Study 2). For this, learning-committed leadership is effective (Crans et al., 2022). Although IWL is less organizationally driven than formal learning (Tannenbaum & Wolfson, 2022), organizations and supervisors can specifically promote informal learning activities and a positive learning culture to strengthen plasticity and work ability throughout the career (Pak et al., 2023).

At the *employee level*, the studies' findings suggest self-regulation and occupational self-efficacy are drivers of employee development and successful aging, highlighting the close connection between employee development and work-related experiences (Scheibe & Kooij, 2024). Because occupational self-efficacy has been identified as a predictor for enhancing OFTP, which in turn promotes job crafting behavior (Study 3), employees should be activated to generate and perceive mastery, positive work and career outcomes (Parker et al., 2021; Zacher, 2022). Similarly, self-regulation strategies have been suggested as an important mechanism for proactively managing changing work environments to support IWL (Study 2) and to deal with developmental changes (e.g., OFTP) by adjusting task characteristics (Study 3). Self-regulation interventions can be provided on different ways – both formally (e.g., self-regulation trainings to cope with demands on flexible work designs, Althammer et al., 2025; trainings to stimulate job crafting; Demerouti & Bakker, 2014) or integrated into work routines, for example, through reflection phases (Kittel et al., 2021).

Summarized, it is essential to focus on interventions at multiple levels to enable an age-sensitive, learning-oriented, and dynamic work design because they are often interrelated and should be considered simultaneously (Boehm et al., 2021; Parker & Jorristma, 2021).

6.3 Limitations and Future Directions

The dissertation presents an interesting combination of different perspectives on work design. Using various methodological approaches, it provides valuable insight into the relationship between work design, health, IWL, and OFTP. It extends traditional top-down approaches of work design by including elements of proactive work design, and it contributes thereby to the understanding of successful ageing at work. However, there are also some gaps that future research could address. In the following, I will first discuss the studies' limitations and directions for future research and then outline implications for the overarching topic.

With regard to the literature review (Study 1), a primary methodological limitation concerns the healthy worker survivor bias (HWSB)[3] which describes that health risks for younger employees may be overestimated, while those for older employees may be underestimated (Buckley et al., 2015). In terms of the review's results, this means, for example, that health risk of high quantitative work demands, and high strain jobs may be underestimated for older age groups. To reduce the HWBS in further research, stratification and controlling for confounders (e.g., employment duration) should be addressed (Buckley et al., 2015). Longitudinal cohort studies could examine health trajectories, with particular attention to individuals who leave the organization (i.e., Kaboth, 2025; Kivimäki et al., 2000). A further limitation relates to the fact that the review's analyses relied on age groups instead of individual age (e.g., Lallukka et al., 2019). Finally, it would be useful in future research to consider alternative operationalizations of age that capture the variation in how employees perceive aging at work according to job characteristics (e.g., subjective age, OFTP).

With regard to the conceptual study (Study 2), one limitation is that the underlying assumptions have not yet been empirically tested. A randomized controlled trial could help to clarify the hypothesized mechanisms that may cause differences in IWL in telework settings compared with more traditional office settings. It could also specify which job characteristics may foster IWL. Additionally, reciprocal analyses using multi-wave data could gain deeper insights into the dynamic interplay of job characteristics and IWL, for example via job crafting activities (Decius et al., 2023b). This would provide empirical validation of the active shaper hypothesis (De Lange et al., 2010), which posits that learning and development initiate the adaptation of work conditions, thereby enhancing job resources, job demands, and social support. Such analyses would also complement the results of Study 3, which examined reciprocal associations between learning-related task characteristics and job crafting. To

[3] The HWSB is a specific, time-dependent component of the HWE. While the HWE describes how workers tend to appear healthier than the general population, the HWSB refers to a bias within the working population itself.

explore the role of supervisors and to integrate the informal learning perspective on work design, future research could empirically combine e-leadership research (Avolio et al., 2000; van Wart et al., 2019) with IWL research. Such studies could analyze how telework and IWL mutually shape and possibly enhance each other (Adaptive Structuration Theory; DeSanctis & Poole, 1994). Furthermore, age could be examined as a moderating factor of self-regulation, integrating lifespan and learning perspectives within telework settings. In this context, recent research shows that older teleworkers demonstrate better boundary management tactics, which lead to higher productivity and better work-life balance (Scheibe et al., 2024). Similarly, older employees show more adaptive responsiveness and a better psychological detachment from work under high availability demands (Venz & Wöhrmann, 2023). Accordingly, higher age could be considered a beneficial factor for dealing with new work demands and IWL.

With regard to the primary empirical study (Study 3), an improved conceptual understanding of learning-related task characteristics in relation to ART (Frese & Zapf, 1994) would help to further develop this theoretical framework. Moreover, an analysis of learning-related task characteristics and their relationship to IWL, as well as the potential moderating role of chronological age and OFTP, would support the understanding of work design from a lifespan and learning perspective. Similar to Study 1, non-linear effects should also be tested (Cadiz et al., 2019), thereby potentially providing further insights into the observed positive association between learning-related task characteristics and subsequent prevention-focused job crafting. A methodological limitation of Study 3 is its exclusive use of self-report data, thus introducing the potential risk of a common method bias (Podsakoff et al., 2003). Future research should consider integrating alternative data sources, for example job analysis, interviews or supervisor ratings. Furthermore, cross-lagged panel models have been criticized for failing to differentiate between within-person processes and stable between-person differences, as well as for autoregressive relationships that do not account for stable

constructs very well (Hamaker et al., 2015). To address these limitations and strengthen the generalizability of the findings to other contexts, replication studies applying the random intercept cross-lagged panel model (RI-CLPM; Hamaker et al., 2015) or structural equation modeling with latent variables with more data waves and larger sample sizes are recommended.

In addition to the specific recommendations relating to the three studies, there are general aspects that future research should consider. With regard to the dissertation's overarching topic of work design, there are two key areas that could be addressed in future research. The first aspect concerns a closer and more concrete conceptual integration of the different perspectives. To better integrate lifespan and learning perspectives, future research should adopt a continuous learning approach to work design. In particular, examining the relationship between learning-related work design and cognitive aging in more detail could improve the understanding of how aging and work design interact with IWL. On the one hand, this would address a cognitively enriching pathway, assuming cognitive preservation by a corresponding work design (Oltmans et al., 2017; Parker et al., 2021). On the other hand, the potentially strain-inducing, cognitive-harmful pathway of work design should also be considered, especially in the context of new technologies and psychosocial workplace hazards (e.g., autonomy paradox; Fraccaroli et al., 2024; Vassiley et al., 2025). Accordingly, the integration of ARAL theory (Zacher et al., 2016) and WDGM (Parker, 2017) would contribute to a better understanding of strengthening continuous informal learning and successful aging at work by an appropriate work design. In a broader social context, future research should also address inequalities in work design, because favorable working conditions and learning opportunities, as well as self-regulation and health-related competencies, vary systematically among employees (e.g., Fraccaroli et al., 2024).

The second aspect relates to methodological improvements and addresses the shared responsibility for redesigning jobs. Most research implicitly assumes that employees are

stable in their job within a single organization throughout their careers. However, workplaces and careers are increasingly dynamic, and organization-centric approaches may no longer be adequate. Therefore, a person-centered view on adaptations and interventions is necessary. This would emphasize the growing importance of employees taking responsibility for their learning, development, and aging (Beier et al., 2025). Moreover, multi-level and intervention studies investigating how employees can successfully redesign their jobs can provide valuable insights for rethinking work design (Fraccaroli et al., 2024). Especially within-person and longitudinal designs could provide insights into such adaptation processes. For example, it would be interesting to analyze trajectories of effective self-regulation for successful aging in terms of health (Study 1), IWL (Study 2), or proactive work design (Study 3).

6.4 Conclusion

The dissertation examined from a lifespan, a learning, and an integrated perspective how work design can contribute to improving employee's health across the lifespan, promoting IWL in telework arrangements, and prolonging OFTP. The findings indicate that tailoring job characteristics through an age-sensitive work design can foster employee health by enhancing key job resources and reducing excessive demands throughout the career. Moreover, a learning-oriented work design facilitates IWL in telework settings by clarifying social processes, defining role boundaries, and managing self-regulation demands with supervisory support. Although learning-related task characteristics neither initiate job crafting behavior nor broaden OFTP, OFTP encourages employees to modify their job characteristics via job crafting. Therefore, dynamic and adaptable working conditions enable employees to learn and age successfully.

Together, the findings show how lifespan and learning perspectives on work design can transform the potential of job characteristics to contribute to continuous informal learning and to successful aging at work. Thus, beyond organizations and supervisors, employees' self-regulation behavior is pivotal for enabling learning and adapting job characteristics.

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*The asterisked entries are included studies from the literature search (Study 1).

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Appendix A

Studies comprising the dissertation

The three studies comprising this dissertation are the following.

- Study 1: Mühlenbrock, I., & Hüffmeier, J. (2020). Differential Work Design for Different Age Groups?. *Zeitschrift für Arbeits- und Organisationspsychologie*, *64*(3), 171–195. https://doi.org/10.1026/0932-4089/a000330
- Study 2: Mühlenbrock, I., Richter, G., Ellerkamp, A., & Wöhrmann, A. M. (2023). How does telework modify informal workplace learning and how can supervisors provide support?. *Gruppe. Interaktion. Organisation. Zeitschrift für Angewandte Organisationspsychologie (GIO), 54*(3), 311-321. https://doi.org/10.1007/s11612-023-00692-7
- Study 3: Mühlenbrock, I., Wöhrmann, A. M., & Hüffmeier, J. (2025). Can Job-Related and Personal Resources Extend Occupational Future Time Perspective? The Mediating Role of Job Crafting (Manuscript submitted for publication. The article has been uploaded to the Open Science Framework [OSF] and is available at: https://doi.org/10.31219/osf.io/qcz96_v1)

Appendix B

Roles and contribution of the (co-)authors of the studies

	Study 1		Study 2				Study 3		
	IM	JH	IM	GR	AE	AW	IM	AW	JH
Conceptualization	X	X	X	X			X		X
Methodology	X	X	X				X	X	X
Formal Analysis	X		X				X		
Investigation	X		X		X		X		
Data Curation	X		X				X		
Writing – Original Draft	X		X				X		
Writing – Review & Editing	X	X	X			X	X	X	X
Supervision		X		X				X	

Note. IM = Inga Mühlenbrock, JH = Joachim Hüffmeier, GR = Götz Richter, AE = Amelie Ellerkamp, AW = Anne Marit Wöhrmann. The types of contribution are based on the Contributor Roles Taxonomy.

Appendix C

Search Term (supplementary file)

EBSCO (PsycINFO, PsycARTICLES und PSYNDEX): 464 articles retrieved

(("older workers" OR lifespan OR aging OR ageing OR "age groups" OR "age differences" OR lifespan OR "aging workforce" OR "ageing workforce" OR "age-related" OR "age-associated" OR age-dependent OR "older workforce" OR "Age effects" OR "Age as a moderator") OR SU age) AND ("work design" OR "job design" OR "work characteristics" OR "job characteristics" OR "work conditions" OR "working conditions" OR "work environment" OR "work environment on employee mental health and wellbeing" OR "working environment" OR "psychosocial work environment" OR "psychosocial job factors" OR "psychosocial work environment" OR "psychosocial work factors" OR "psychosocial work environment and mental health" OR "psychosocial work characteristics") AND TX (Health OR well-being OR "well being" OR "work ability" OR work-ability); Limiters - Publication Year: 2000-2017; Peer Reviewed, Narrow by SubjectAge: - young adulthood (18-29 yrs), Narrow by SubjectAge: - thirties (30-39 yrs), Narrow by SubjectAge: - middle age (40-64 yrs), Narrow by Language: - german, Narrow by Language: - english, Search modes - Boolean/Phrase

PubMed: 221 articles retrieved

((("older workers"[Title/Abstract] OR lifespan[Title/Abstract] OR Aging[Title/Abstract] OR ageing[Title/Abstract] OR "age groups"[Title/Abstract] OR "age differences"[Title/Abstract] OR lifespan[Title/Abstract] OR "aging workforce"[Title/Abstract] OR "ageing workforce"[Title/Abstract] OR "age-related"[Title/Abstract] OR "age-associated"[Title/Abstract] OR age-

dependent[Title/Abstract] OR "older workforce"[Title/Abstract] OR "Age effects"[Title/Abstract]) AND (("1990/01/01"[PDAT] : "3000/12/31"[PDAT]) AND "humans"[MeSH Terms] AND (English[lang] OR German[lang]))) AND (("work design"[Title/Abstract] OR "job design"[Title/Abstract] OR "work characteristics"[Title/Abstract] OR "job characteristics"[Title/Abstract] OR "work conditions"[Title/Abstract] OR "working conditions"[Title/Abstract] OR "work environment"[Title/Abstract] OR "working environment"[Title/Abstract] OR "psychosocial work environment"[Title/Abstract] OR "psychosocial job factors"[Title/Abstract] OR "psychosocial work factors"[Title/Abstract]) AND (("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) AND "humans"[MeSH Terms] AND (English[lang] OR German[lang]))) AND (("health"[MeSH Terms] OR "health"[All Fields]) OR ("health"[MeSH Terms] OR "health"[All Fields] OR "well"[All Fields] OR "well being"[All Fields]) OR "well being"[All Fields] OR work-ability[All Fields] OR "work ability"[All Fields]) AND (("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) AND "humans"[MeSH Terms] AND (English[lang] OR German[lang])))

Appendix D

Preregistration Deviations Table

#	Details		Original Wording	Deviation Description	Reader Impact
1	Type	Other (Please Explain)	We used the term “task-related learning opportunities” in the preregistration.	We changed the term into “learning-related task characteristics” to accord with the term used in the original validation study introducing the measure (Richter & Wardanjan, 2000).	The deviation does not affect the reader because the construct is not widely known and the term is not standardized.
	Reason	Typo/Error			
	Timing	After results known			
2	Type	Hypotheses	“Hypothesis 1: Task-related learning opportunities (t1) are positively associated with OFTP (t2). Hypothesis 2: Occupational self-efficacy (t1) is positively associated with OFTP (t2). Hypothesis 3a: Task-related learning opportunities (t1) are positively associated with promotion-focused job crafting (t1). Hypothesis 3b: Task-related learning opportunities (t1) are negatively associated with prevention-focused job crafting (t1). Hypothesis 4a: Occupational self-efficacy (t1) is positively associated with	We specified the wording of all hypotheses to implement a more appropriate way to test them. Originally, we planned to test the hypotheses of our two-wave study using a half-longitudinal design. This means that either the predictor (X) or the outcome variable (Y) coincides in time with the mediator variable (M) having two measurement occasions. In the process of analyzing the data, we realized that there are better analytical procedures to do this. Thus, we now follow Cole and Maxwell’s (2003) recommendation to conduct a pair of longitudinal tests to avoid biased	The deviations specify all hypotheses because the phrase "affect" is employed in place of "associate."
	Reason	New knowledge			
	Timing	After data access			

			promotion-focused job crafting (t1). Hypothesis 4b: Occupational self-efficacy (t1) is negatively associated with prevention-focused job crafting (t1). Hypothesis 5a: Task-related learning opportunities (t1) are indirectly and positively associated with OFTP (t2) via promotion-focused job crafting (t1). Hypothesis 5b: Occupational self-efficacy (t1) is indirectly and positively related to OFTP (t2) via promotion-focused job crafting (t1). Hypothesis 6a: Task-related learning opportunities (t1) are indirectly and negatively related to OFTP (t2) via prevention-focused job crafting (t1). Hypothesis 6b: Occupational self-efficacy (t1) is indirectly and negatively related to OFTP (t2) via prevention-focused job crafting (t1)."	effects. We estimated path a in the regression of M(T2) onto X(T1) while controlling for M(T1) and estimated path b in the regression of Y(T2) onto M(T1) controlling for Y(T1). In turn, we rephrased our hypotheses.	
3	Type	Variables	"We will apply structural equation modeling [SEM] to test our hypotheses."	Due to power considerations, we use aggregated observed variables instead of latent variables to represent all variables in our time-lagged reciprocal model.	This deviation has an impact on readers' interpretations of the findings. SEMs facilitate more precise modeling of complex associations and an explicit modeling of measurement errors, thereby enabling more precise and realistic estimation. However, we examined common method
	Reason	Plan not possible			
	Timing	After data access			

					variance at both measurement occasions, and the explained variances did not indicate a significant impact in our data thereby lessening concerns about common method variance influencing our findings.
4	Type	Other (Please Explain)	"Three publications with a different research interest than job crafting and occupational future time perspective have been published from the same data set (see Richter, Mühlenbrock, & Ribbat, 2018; Richter, Ribbat, & Mühlenbrock, 2020; Ribbat, Krumm, & Hüffmeier, 2021). The focus was on followership behavior, learning-supportive leadership, and job design."	Unfortunately, we named one publication wrong (Ribbat, Krumm, & Hüffmeier, 2021). Instead, it is "Ribbat, Nohe, & Hüffmeier (2023)". Its focus is on followership behavior and its relationship with job satisfaction, organizational commitment, and occupational self-efficacy.	The discrepancy in the references does not affect the reader, as both citations address the same though distinct topic, namely followership behavior.
	Reason	Typo/Error			
	Timing	After data access			
5	Type	Other (Please Explain)	"This document will be preregistered in August 2021. The analyses will start immediately after the preregistration."	In the preregistration, we planned to start with the analyses in autumn 2021. Due to other scientific priorities, our activities have been delayed.	This deviation has no impact on the reader.
	Reason	Plan not possible			
	Timing	Before data access			

Note. We did not apply any unregistered steps.

Affidavit of Originality

(Eidesstattliche Erklärung)

Hiermit versichere ich **schriftlich** und **eidesstattlich** gemäß § 11 Abs. 2 PromO v. 08.02.2011/08.05.2013:

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