Fachbereich Erziehungswissenschaft und Psychologie
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# Aging in a Digital World -
# Attitudes and Behaviors towards Technology Use Across the Life-span

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## Abstract

This dissertation addressed two major issues of our time: the proliferation of technologies and the aging of society. The overall goal of this dissertation was to better understand how age relates to the distinct parts of the technology adoption process: For one, the role of age was analyzed in relation to determinants of technology use (study 1) and for another, age was analyzed in relation to technostress and coping behaviors (study 2).

Study 1 investigated how chronological age related to technology acceptance. A meta-analysis including 144 studies was conducted to integrate inconsistent results of previous studies. Results showed aggregated negative bivariate relationships between age and determinants of technology use (PEOU, PU, and ITU). However, a meta-analytic path model including all variables revealed that when indirect effects were taken into account, age was neither directly related to PU nor to ITU. Moderated mediation analyses revealed that age effects were moderated by type of technology. Bivariate relationships were stable over time and across mandatory and voluntary settings. Thus, this study helped to bring much needed closure to inconsistent findings on age and technology acceptance.

Study 2 investigated the interplay between chronological age and technology-related strain mediated by techno-stressors and coping strategy choices in organizational settings. Longitudinal data from 1,216 employees over a time period of 8 months were used to perform multilevel mediation modeling. Age was negatively associated with technology-related strain. This relationship was mediated through behavioral disengagement, which older workers used less than younger workers. Active coping and social coping did not act as mediators of this relationship. Understanding these processes allows modifying coping strategy choices in employees and mitigate negative outcomes of technostress at the workplace.

The results of this dissertation provide a base for a more comprehensive understanding of older adults as users and consumers of technology, especially in the work context and, furthermore, devaluate common age stereotypes.

# Chapter 1

## INTRODUCTION

## The Silver Economy

Dealing with and continuously adapting to new technologies is a major societal challenge of our time. Technologies have become an integral component of work, health, entertainment, communication, and education. Industries rely more and more on technologies in order to stay competitive and to meet the growing complexities of a globalized world (Brettel, Friederichsen, Keller, & Rosenberg, 2014). The diffusion of information and communication technologies (ICT) is a key driver for economic growth and productivity (Meyn, 2017; Mossberger, Tolbert, & McNeal, 2007; Tarutė & Gatautis, 2014). Therefore it is not surprising that the digitization of workplaces is predicted to proceed quickly in almost all industries (Chhabra, 2018). The proliferation of technologies is shaping and changing the way we work, entailing advantages, challenges, and risks for employees. On the one hand, ICTs enable employees to work more flexible—in many occupations work is no longer bound to a certain time or place (Berg-Beckhoff, Nielsen, & Ladekjær Larsen, 2017). On the other hand, employees are challenged to develop specific technology-related skills, knowledge and abilities to work in virtual settings (Schulze & Krumm, 2017; Schulze, Schultze, West, & Krumm, 2017; Y. Wang & Haggerty, 2011). Yet, the same technological developments that bring benefits also carry inherent risks. The potential adverse consequences deriving from the inability to cope with ICT-related demands are well documented (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008; Tarafdar, Pullins, & Ragu-Nathan, 2015; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2007; Tarafdar, Tu, & Ragu-Nathan, 2010).

Challenges posed by the digitization of workplaces are further compounded by societal changes such as the aging of society (OECD, 2018; United Nations, 2017). In the wake of the demographic change, organizations are confronted with a growing proportion of older adults within the workforce (OECD, 2017b, 2018). The alteration of the age group composition, also referred to as the *greying of the workforce*, is not merely a phenomenon of the past and present, but is predicted to further increase over the next decades (OECD, 2011;

United Nations, 2001). This positive development regarding employment of older adults, is accompanied by profound implications against the background of the digitization of workplaces. Several studies indicate that older adults have greater difficulties to keep pace with the technological progress (Chen & Chan, 2011; Lee & Coughlin, 2015; Olson, O'Brien, Rogers, & Charness, 2011; Tams, Grover, & Thatcher, 2014; Wagner, Hassanein, & Head, 2010). Consequently, demands relating to the use of ICTs may be perceived as particularly taxing by older workers. In order to meet these societal and economic challenges, international experts call for policy actions that enhance an inclusive digital economy, and age-friendly work environments (OECD, 2015). This dissertation aims to contribute to answering this call by providing insights into the intertwining processes between age, technology acceptance and the experience of technology-related stress.

## Aging in a digital world

This chapter begins with the introduction of several important aspects of technology use in relation to age. The second and third section of this chapter will address the main topics of the present dissertation (technology acceptance and technostress). The last section will give an overview of the main research question and structure of the dissertation.

**Digital divide.** The term digital age divide refers to differences in internet adoption rates between age groups. For example, in 2016 almost all of the younger individuals (96.5%; aged 16-24) used the internet, whereas only 62.8% of the older individuals did (aged 55 and older; OECD, 2017a). Even in industrialized countries, where the digital diffusion is almost exhausted within younger cohorts, it still is an issue across generations (Friemel, 2016; Schelling & Seifert, 2010). On a closer inspection, age differences not only occur with regard to internet use, but also in regard to the usage purpose. Older adults are pursuing a narrower scope of goals and activities online than younger adults (Wei, 2012). Research showed that older adults use ICTs mainly for communicating with family members and accessing online health information, whereas the breadth of activities is much greater for younger adults (Olson et al., 2011; Vroman, Arthanat, & Lysack, 2015).

Moreover, a digital age divide exists not only in terms of having access or using digital media, but also in terms of technology skills—which is considered a second level digital divide (Hargittai, 2001; Q.E. Wang, Myers, & Sundaram, 2013). Such skills include ICT literacy (Ferro, Gil-Garcia, & Helbig, 2007; Ferro, Helbig, & Gil-Garcia, 2011), computer self-efficacy (Mun & Hwang, 2003; Shu, Tu, & Wang, 2011; Tams, Craig, & Murphy, 2011; Wild et al., 2012), ICT competency (Guo, Dobson, & Petrina, 2008), or digital fluency (Q. E. Wang et al., 2013; Y. Wang & Haggerty, 2011). Research suggests that older adults possess lower levels of technology skills due less experience in handling technologies, and physiological and cognitive disadvantages compared to younger adults (Westerman & Davies, 2000). Furthermore, attitudinal differences (e.g., the perceived benefit, perceptions of potential dangers, perceived difficulty of handling of using a system) between younger and older adults have been associated with lower levels of ICT skills and lower ICT adoption rates in older adults (Blaschke, Freddolino, & Mullen, 2009; Donat, Brandtweiner, & Kerschbaum, 2009). Hence, technology skills and motivation are main drivers for ICT use (Donat et al., 2009). ICT use and ICT skills have become pivotal for actively participating in the economy and society (OECD, 2017a). For example, digital exclusion brings about a whole range of negative consequences for individuals. Not receiving online information negatively affects political participation (Wei, 2012), health and well-being (Dobransky & Hargittai, 2012), social inclusion and social support (Nimrod, 2010, 2014), as well as labor market chances (Mossberger et al., 2007). Hence, exploring the drivers and barriers for acquiring technology skills in older adults is crucial in terms of creating an inclusive digital economy and to make benefits of ICT use available to older adults.

**Ageism.** Age discrimination or ageism is defined as “prejudices from one age group towards other age groups” (Butler, 1969, p. 243). Ageism might play an essential role in the digital age divide (McDonough, 2016). Older adults are confronted with numerous discriminating attitudes in advertisement, media, but also in the work context. For example, elderly are stereotyped as warm but incompetent consistently across cultures (Cuddy, Norton, & Fiske, 2005). Stereotypes towards older adults and technology use include older adults being uninterested in using technologies, less ready to accept new technology, being technophobic, less adaptable to change, less interested in training, and unable, unwilling, or afraid to use technology (Chiu, Chan, Snape, & Redman, 2001; Cutler, 2005; McDonough, 2016; Mitzner et al., 2010; Neves & Amaro, 2012; Posthuma & Campion, 2008). Such stereotypical views about older adults may negatively influence technology adoption decisions as well as attitudes towards technologies in older adults. According to the theory of reasoned action people are willing to comply with a certain behavior, if they believe that significant others think they should (Ajzen & Fishbein, 1980). Social influence processes, e.g., compliance, identification, and internalization, shape the perception and usage intentions in the context of technology (Venkatesh & Davis, 2000; Warshaw, 1980). Internalization and identification describe processes of changing one’s own belief structures in accordance to external belief structures. For example, individuals interpret information from significant others as evidence about reality and integrate them in their own believes. Indeed, previous studies showed that social norms positively predict the level of technology acceptance (Legris, Ingham, & Collerette, 2003; Morris, Venkatesh, & Ackerman, 2005; Schepers & Wetzels, 2007; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). Furthermore, research showed that older adults relied more on social factors in their technology acceptance decisions than younger adults (Chung, Park, Wang, Fulk, & McLaughlin, 2010). Hence, older workers might be especially sensitive to age-related stereotypes they are confronted with. Additionally, meta-stereotyping describes the phenomenon that individuals are influenced in their attitudes and behaviors not only by the stereotypes they actually encounter, but also by the stereotypes they think others may hold about them (Finkelstein, King, & Voyles, 2015). Thus, if older adults *think* important others have negative opinion about them using a technology, they might be less likely to accept the technology. Finally, self-stereotyping refers to mechanisms in which older adults might be convinced that a stereotype is true (e.g., that they are less adaptable to change, less willing and capable to learn and grasp new ideas) and, consequently, underestimate their competencies and skills (Staudinger, 2015). Self-stereotyping might therefore be one relevant component in explaining lower levels of confidence concerning technology-related skills in older adults. Indeed, research suggested that older adults underestimated their actual computer knowledge, which in turn may lead to difficulties in mastering new technology skills (Marquié, Jourdan-Boddaert, & Huet, 2002).

In addition, it has been pointed out that ageism and technology use might reciprocally influence each other: Ageism can be an obstacle in adopting technologies, but at the same time, the adoption of technologies by elderly may both enhance or debunk ageism (Cutler, 2005). Enhancing technology adoption within the group of older adults might go hand in hand with abolishing prevailing age stereotypes about older adults.

**Technology Acceptance**

Technology acceptance is defined as having favorable attitudes towards a technology as well as the ongoing use of a technology (Arning & Ziefle, 2007). This definition emphasizes the two-sided nature of technology acceptance: the attitudinal components (e.g., individual believes) and behavioral components (the actual use).

The technology acceptance model (TAM) by Davis (Davis, 1989) has become the most dominant model within the technology acceptance research. Based on the theory of reasoned action (Ajzen & Fishbein, 1980) TAM suggests that three key drivers predict actual technology use: the perceived ease of use (PEOU), the perceived usefulness (PU), and the intention to use (ITU) a technology (Davis, 1989). Figure 1 provides an overview of the theoretical framework of technology acceptance model and four determinants of technology acceptance according to TAM 3 (Venkatesh & Bala, 2008). PEOU refers to the degree to which a person believes that using a system will be free of effort (Davis, 1989). Hence, PEOU is mainly influenced by individual difference variables (Venkatesh & Bala, 2008). PU refers to the degree to which a person believes that using a system will enhance one's performance (Davis, 1989). Hence, PU relates to the perceived benefits of using a system (Venkatesh & Bala, 2008). PU is positively associated with PEOU, as such that the appraisal of PU depends on the perceived costs (e.g., time and effort) an individual has to invest in order to adopt a technology. Thus, all other determinants being equal, the technology which is easier to use is perceived as being more useful. Therefore, the relationship between ITU and PU is partially mediated through PEOU.

Individual difference variables include personality traits as well as demographic variables and are associated with POEU and PU (Venkatesh & Davis, 2000). For example, PEOU is associated with general beliefs of an individual regarding their own technology-related ability (Venkatesh & Davis, 2000). Such general beliefs comprise computer self-efficacy, computer anxiety, and perceptions of external control (Venkatesh & Davis, 2000). General beliefs depend on an individual's prior experiences, intrinsic motivation and beliefs about the own technology-specific ability. System characteristics are features of a technology that relate to a specific need (e.g., enhancing the job performance; Venkatesh & Davis, 2000). Hence, features of a technology are associated with both PU and PEOU (Venkatesh & Bala, 2008). Social influence processes relate to social mechanisms that influence an individual in their own perception regarding a technology (Venkatesh & Bala, 2008). Social influences (e.g., compliance, identification, internalization; Warshaw, 1980) are positively associated with PU and ITU (Venkatesh & Bala, 2008; Venkatesh et al., 2003). Furthermore, the effects of social influences should attenuate over time as individuals accumulate own experiences with a technology. Finally, facilitating conditions refer to organizational support and are positively associated with ITU (Venkatesh & Bala, 2008).

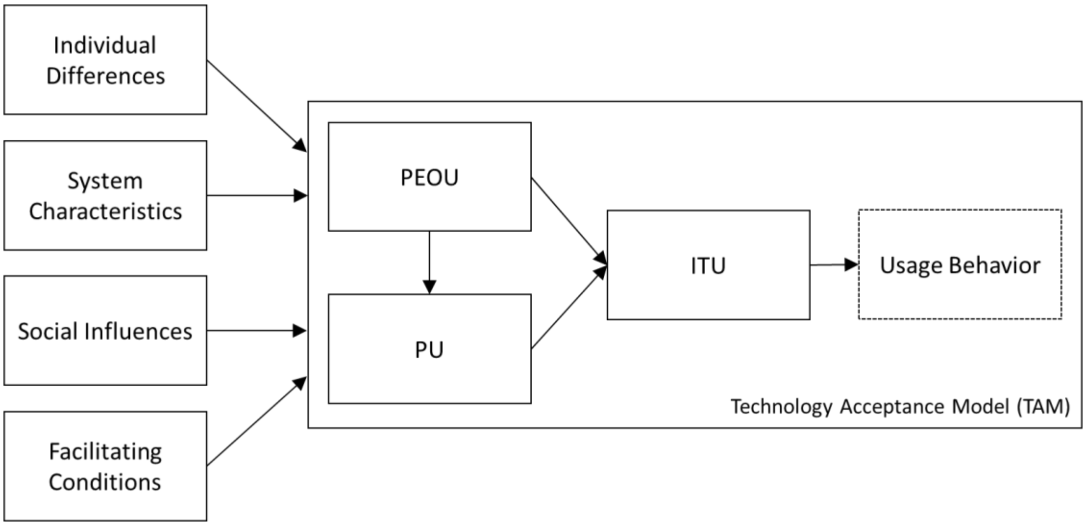


*Figure 1.1.* Theoretical Framework of Technology Acceptance Model 3. Reprinted from "Technology Acceptance Model 3 and a Research Agenda on Interventions," by Venkatesh V., and Balla, H., 2008, *Decision Sciences, 39* (2), p. 276.

A series of TAM-based models have been developed, which extend or modify the original TAM. An overview of publications dealing with modifications and extensions of the original TAM is presented in Marangunić (Marangunić & Granić, 2015). Yet, PEOU and PU have been kept as the two core determinants of ITU in all the extended versions of the TAM. The validity and robustness of the TAM models have been confirmed in many studies and numerous meta-analyses (King & He, 2006; Ma & Liu, 2004; Schepers & Wetzels, 2007; ŠUmak, HeričKo, & PušNik, 2011; van den Hooff, Groot, & de Jonge, 2005; J. Wu & Lederer, 2009; K. Wu, Zhao, Zhu, Tan, & Zheng, 2011; Yousafzai, Foxall, & Pallister, 2007). However, despite the vast amount of research endeavors over the last decades it still is unclear how chronological age relates to the core TAM variables. A possible explanation for the inconsistency in the previous results may be that studies employed a variety of technologies, types of samples, and research models that included different predictor variables.

The relationship between age and technology acceptance will be extensively addressed in in chapter 3. Thus, this chapter goes on with an introduction of the concepts technostress and techno-eustress as important variables within the technology usage context.

## Technostress and Techno-eustress

The digitization of work is viewed as a double edged sword, creating both benefits and detrimental effects (Fischer & Riedl, 2015). The dark side of technology use refers to stress in relation to the handling of ICTs, commonly referred to as technostress (Ragu-Nathan et al., 2008; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2011). The bride side refers to positive stress individuals experience from using a technology (Tarafdar, Cooper, & Stich, 2017). Both sides are viewed as ends of the same continuum (Gaudioso, 2017). Most of the scientific research endeavors so far focused on technostress creating situations and technostress inhibiting factors. These factors will be introduced and briefly described in the following paragraphs.

**Technostress.** The implementation and use of technologies poses challenges to employees which can be perceived as threatening in case that technological demands exceed individuals' abilities to meet them. Technostress comprises the overall transactional process of evolving stress in relation to technology use (Galluch, Grover, & Thatcher, 2015). Techno-stressors refer to specific situations in which ICT-related demands exceed an individuals' ability to meet them (Ragu-Nathan et al., 2008; Tarafdar et al., 2007). Five techno-stressors have been identified by previous research: techno-invasion, techno-overload, techno-uncertainty, techno-insecurity, and techno-complexity (Ragu-Nathan et al., 2008; Tarafdar et al., 2007). Based on the person-environment-fit model (French, Caplan, & Van Harrison, 1982), research suggests that situations related to role ambiguity and work overload are the most dominant techno-stressors (Ayyagari, Grover, & Purvis, 2011). These situations are created through intrusive technology characteristics such as a lack of anonymity and constant presenteeism facilitated by ICTs (techno-invasion; Ayyagari et al., 2011). Furthermore, studies showed that technology-related interruptions, such as incoming emails or instant messages, are positively associated with individuals' stress level (techno-overload; Galluch et al., 2015; Tams, 2011). Consequences of the inability to cope with ICT-related demands in relation to job-outcomes are decreased levels of job satisfaction, lower performance, lower organizational commitment, role overload, role conflict, higher levels of burnout, and lower work engagement (Ragu-Nathan et al., 2008; Reinke & Chamorro-Premuzic, 2014; Tarafdar et al., 2015). Further, one study showed that constantly changing applications, as well as frequent changes of the terms and conditions in social media platforms lead to higher technology-related exhaustion and higher discontinuance intentions (techno-uncertainty; Maier, Laumer, Weinert, & Weitzel, 2015). High complexity of technology characteristics is associated with the feeling of incompetence and higher levels of perceived work-load in employees (techno-complexity; Wang, Shu, & Tu, 2008). Finally, technology use in work settings may lead to increased job insecurity—the fear of losing one's job due to technological developments (techno-insecurity; Ayyagari et al., 2011). But also in the private context people of all age groups are connected to a constant stream of online content and computer mediated communication (Vorderer & Kohring, 2013). Hence, the perception of being bound to a social expectation of availability at all times, of being overwhelmed by the sheer mass of online information, and combining multiple online activities might be perceived as a taxing situation in relation to ICT use (Misra & Stokols, 2012).

Several technostress inhibiting factors, also referred to as facilitating conditions, have been identified. Research showed that ICT training reduced the perceived complexity of new technologies (Tu, Wang, & Shu, 2005). The implementation of organizational IT-support was associated with lower levels of the perceived complexity as well as with lower levels of insecurity about new technologies (Tu et al., 2005). Another study showed that the level of power centralization in an organization and employees' lack of participation in the decision-making processes concerning new technologies was associated with higher levels of perceived techno-stressors (Wang et al., 2008). Hence, beneficial measures in reducing the level of techno-stressors among employees are encouraging the exchange of ICT-related knowledge among employees (literacy facilitation), providing technical support within the organization (innovation support), and informing employees about technological changes and encouraging them to use new ICTs (involvement facilitation; Ragu-Nathan et al., 2008; Tarafdar et al., 2010; Tarafdar et al., 2011). Furthermore, these technostress inhibiting mechanisms are not only associated with lower levels in experienced techno-stressors, but are also associated with higher levels in psychological and behavioral outcomes, e.g. end-user satisfaction, job satisfaction, performance and productivity (Ragu-Nathan et al., 2008; Tarafdar et al., 2015; Tarafdar et al., 2010; Tarafdar et al., 2011).

**Techno-eustress.** Techno eustress refers to positive stress individuals experience from using a technology. For example, individuals may feel motivated to tackle challenging ICT situations, in case “they expect that doing so is within their wherewithal and would lead to betterment, activate coping behaviours to master the challenges in a positive way, and achieve largely affirmative and positive outcomes.” (Tarafdar et al., 2017; p. 9). Based on appraisal processes, disruptive events can be perceived either as a threat (having negative consequences) or an opportunity (having positive consequences; A. Beaudry & Pinsonneault, 2005; McCrae & Costa, 1986). Studies showed that the appraisal of demanding ICT-situations as being either positive or negative is associated with their personality (Srivastava, Chandra, & Shirish, 2015). For example, people with a hardy personality (with high levels in alterness, ambition, and intrinsic motivation) are more likely to perceive demanding situations as opportunities (Tarafdar et al., 2017). Hence, individuals with high levels in these traits would be more likely to perceive situations related to ICT use as possibilities to blur work and private life boundaries in a healthy and productive way, to enhance productive multitasking, and to improve their work practice through innovative ICT solutions (Beaudry &

Pinsonneault, 2005; Tarafdar et al., 2017). Indeed empirical evidence suggests that situations related to the intrusiveness of a technology (e.g., smartphones) can be appraised as an opportunity for increasing the flexibility and productiveness of work (Ohly & Latour, 2014). Furthermore, individuals with low levels of technology self-efficacy might be more likely to perceive job demands as threatening, whereas individuals with high levels in technology competence might be more likely to perceive techno-eustress (Tarafdar et al., 2015). Finally, results of one study showed that techno-invasion can lead to emotional exhaustion as well as to eustress (Diller, Jeffrey, & Fiedler, 2016).

**Coping.** The concept of technostress and techno-eustress are relatively new to the research field. Hence, so far little knowledge exists on how individuals deal with technology-stressors. Generally, coping behaviors could include either changing the stressful situation (e.g., problem-focused coping), changing the way the situation is perceived (e.g., cognitive reappraisal), or retrieval from the situation (e.g., behavioral disengagement; Carver, Scheier, & Weintraub, 1989). In relation to technostress these coping behaviors would translate into i) changing the way a stress-inducing technology is used, for example changing the work procedure (Beaudry & Pinsonneault, 2005), seeking training or assistance (Bala & Venkatesh, 2015; Beaudry & Pinsonneault, 2005), ii) changing the cognition about the technology, for example reinterpreting the techno-stressor in a positive light (Beaudry & Pinsonneault, 2005), or iii) discontinue using the technology, for example temporarily distancing from the techno-stressor (Beaudry & Pinsonneault, 2010).

## The Present Dissertation

The overall goal of this dissertation was to better understand how age relates to different factors in the technology adoption process. Against the backdrop of an aging and technology-reliant society, understanding how, when, and why age relates to technology use becomes pivotal. However, despite great research endeavors, findings of previous studies on age and technology acceptance are heterogeneous and even contradictory. Moreover, research on technostress focused mainly on external variables such as technology characteristics, but more research on individual coping behaviors is needed. So far, no study exists that focused on age as a central variable in the technostress process. Therefore, this dissertation aimed at contributing knowledge on i) age-contingent drivers of technology acceptance and ii) age-related coping strategies in the face of technology-related strain.

The technology adoption process was fragmented into two parts, which have been carefully examined in relation to age (cf. Figure 2). The first part assessed age-effects on determinants of technology use and potential moderators through a meta-analysis (study 1). The second part examined the relationship of age and technostress, as well as coping behaviors as a mediator of this relationship (study 2).

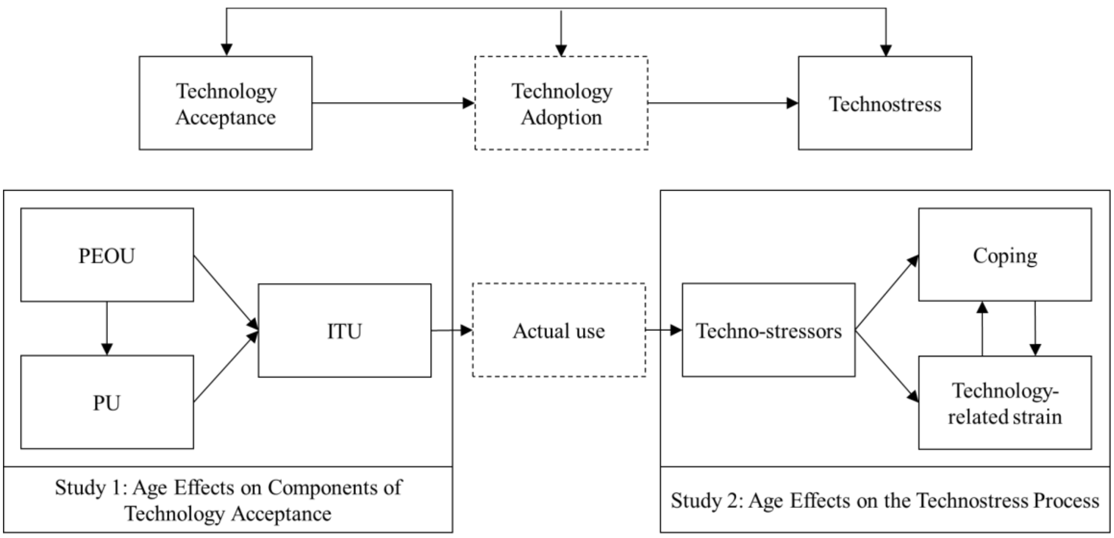


*Figure 1.2.* Simplified Illustration of the Research Model of this Dissertation.

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# Chapter 2

# AGE AND TECHNOLOGY ACCEPTANCE

**Ready to be a Silver Surfer?**

**A Meta-analysis on the Relationship Between Chronological Age and Technology Acceptance**

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**Abstract**

This meta-analysis addresses two major issues of our time: the proliferation of technologies and the aging of society. That is, we investigate how chronological age relates to technology acceptance and delineate an *age-specific* technology acceptance model (TAM; Davis, 1989). Pertinent primary studies reported inconsistent results. To integrate this literature, the current meta-analysis includes 144 studies covering different types of technologies and technology users in a random effects model. In line with our theorizing, we found that age was overall negatively related to perceived ease of use ($\rho = -.25$), perceived usefulness ($\rho = -.09$), and intention to use a technology ($\rho = -.07$). These effects were stable over time and thus no mere cohort effects. A meta-analytic mediation model revealed that the links from age to (a) perceived usefulness and (b) intention to use were both fully mediated through perceived ease of use. Furthermore, results were moderated by type of technology, such that age-effects were only evident for technologies that do not address the prevailing needs of older adults. We conclude that age is related to negative perceptions for specific, but not for all technologies, thus challenging prevailing age stereotypes and calling for an age-sensitive design of specific technologies.

*Keywords*: age, technology acceptance, attitudes towards technology, meta-analysis

# Chapter 3

## AGE AND COPING WITH TECHNOSTRESS

# The mediating role of coping behavior on the age-technostress relationship: a longitudinal multilevel mediation model

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**Abstract**

This study seeks to explain the interplay between chronological age and technology-related strain through techno-stressors and coping strategy choices in organizational settings. Grounded in Lazarus´ stress theory, theories of cognitive aging, life span theory of control and socioemotional selectivity theory, this study argues that even though older workers are more prone to techno-stressors, aging is connected to gaining coping skills, which in turn reduce technology-related strain over time. Understanding these processes allows modifying coping strategy choices in employees and mitigate negative outcomes of technostress at the workplace. Longitudinal data from 1,216 employees over a time period of 8 months were used to perform multilevel mediation modeling. The findings reveal that age was negatively related to technology-related strain. The link between age and technology-related strain was explained through behavioral disengagement, which older workers used less than younger workers. Active coping and social coping did not act as mediators of this relationship across time points. These relationships were stable after controlling for dependency on technology.

*Keywords*: age, technostress, strain, coping, multilevel mediation, MLM

**Introduction**

The increasing number of older employees within the work force (OECD, 2017) as well as the continuous digitization of the work (Brettel, Friederichsen, Keller, & Rosenberg, 2014) raise the question of how chronological age relates to stress that is created through information and communication technology (ICT) usage in occupational settings. Despite the empirical endeavors of research on technology-related stress (hereinafter referred to as *technostress*), the understanding of the relationship between chronological age and technostress is limited. Research showed that ICT dependency at work might induce stress, work exhaustion (F Gaudioso, Turel, & Galimberti, 2015) and several negative consequences for the organization (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008; Tarafdar, Pullins, & Ragu-Nathan, 2015; Tarafdar, Tu, & Ragu-Nathan, 2010). Despite perceiving technologies as useful, older adults have greater difficulty in handling technologies (Hauk, Hüffmeier, & Krumm, 2018). Therefore, older workers might experience more situations in which they feel taxed through ICT-related demands. Yet, as people age, they gain resources and coping abilities, which help them to deal with stress (S. Charles & Carstensen, 2010; Heckhausen & Schulz, 1995; Heckhausen, Wrosch, & Schulz, 2010). The future success of work organizations may depend on a deeper understanding of age-contingent differences in technostress management strategies. The identification of effective coping strategies, which buffer the technostress consequences—especially as the proportion of older workers increases—may be beneficial to develop organizational interventions to help employees cope more effectively with technology-related strain. Therefore, the current study aims to answer the research question: How do workers cope with technostress across the age-span in a digitalized work environment?

In the following sections, we introduce the transactional theory of stress and its application to technostress, followed by an overview on different types of coping strategies.

We then outline our theoretical rationale, first, for age contingency in the experience of technology-related strain, second, for age differences in applying coping strategies and, third, for the mediating role of coping in the age-technostress relationship.

**Technostress and Coping**

Stress refers to an overall transactional process in which environmental demands exceed individuals' capabilities and resources to meet them (Lazarus & Folkman, 1987). Following this notion, technostress is defined as a problem of adaptation due to the inability to cope with ICT-related demands (Ragu-Nathan et al., 2008; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2007). In the following paragraphs the technostress formation process is illustrated based on the transactional theory of stress (Lazarus & Folkman, 1987).

According to the transactional theory of stress, stress is formed through three processes: primary appraisal, secondary appraisal, and coping. Primary appraisal is defined as the process of perceiving a threat to oneself, for example, a perceived misfit between technological demands and one´s own abilities to meet them (Lazarus & Folkman, 1987). Five factors have been identified as determinants of technostress (hereinafter referred to as *techno-stressors*) in occupational settings (Ragu-Nathan et al., 2008; Tarafdar et al., 2007): Techno-overload refers to situations in which users feel forced by ICT to work faster and longer. Techno-invasion refers to situations in which work and private life get blurred by constant availability and connectedness through ICT. Techno-complexity refers to situations in which users feel overwhelmed or incompetent in the face of ICT. Techno-insecurity refers to situations of perceived job insecurity due to the fear of being replaced by either ICT or by workers with greater ICT-skills. Techno-uncertainty refers to situations of unpredictable, continuous ICT-related changes and upgrades.

Secondary appraisal is defined as the process of evaluating available coping resources to handle a perceived threat (Lazarus & Folkman, 1987). Hence, this process depends on individual's resources (e.g., coping competencies), as well as on environmental factors (e.g., situational circumstances). Generally, coping is defined as "adaptational acts that an individual performs in response to disruptive events that occur in his/her environment"

(Beaudry & Pinsonneault, 2005). Accordingly, coping includes problem-focused actions aiming at changing the stressful situation, for example, trying to control the stressful situation step by step (*active coping)* or asking others for help (*seeking instrumental social support*). Other forms of coping include ignoring the stressful situation, denial, or disengagement, for example, interrupting any further interaction and withdrawing from the stressful situation (*behavioral disengagement*). Notably, individuals might engage in more than one strategy at the same time (Beaudry & Pinsonneault, 2005; Folkman & Lazarus, 1980). Therefore, coping strategies are not exclusive and individuals might not only differ by their choice of coping, but also to which extend they engage in either strategy. For example, according to recent research, almost all employees (88.3%) initially try to fix an ICT-related problem or try to seek the source of the problem (Ortiz de Guinea, 2016).

The third process in the stress formation process consists of executing the coping behaviors with the goal of reducing negative consequences (Lazarus & Folkman, 1987). Following common taxonomies of coping, we differentiate between functional and dysfunctional coping. Accordingly, as a result of behavioral disengagement, the experienced strain level declines temporarily but might rise beyond the initial level in case confrontation with the stressor cannot be avoided on the long run (Charles S Carver, Michael F Scheier, & Jagdish K Weintraub, 1989b). Therefore, behavioral disengagement is considered a dysfunctional coping strategy, whereas active coping and seeking instrumental social support are considered functional coping strategies (Carver et al., 1989b). A study on different coping strategies (Fulvio Gaudioso, Turel, & Galimberti, 2017) examined three adaptive coping strategies in the technostress context (active coping, asking for technical support, and planning), as well as two maladaptive coping strategies (denial and behavioral disengagement). In this study employees reacted to technology-related strain mostly with maladaptive coping strategies, which in turn increased work exhaustion, whereas adaptive coping reduced work exhaustion (Fulvio Gaudioso et al., 2017). Hence, strain is not a direct result of experiencing a stressor but rather dependent on resources and coping abilities. Indeed, personal resources, such as emotional and mental competencies, are negatively related to technology-related strain at work (Salanova, Llorens, & Cifre, 2013).

Furthermore, not only coping behavior influences the experience of technology-related strain, but the experience of technology-related strain initiates coping behavior (Lazarus & Folkman, 1987). Such feedback loops may cause individuals to continue coping after perceiving the strain level as still too high. For example, Maier, Laumer, Weiner, and Weitzel (Maier, Laumer, Weinert, & Weitzel, 2015) showed that techno-stressors lead to technology-related exhaustion, and technology-related exhaustion caused behavioral responses, such as avoidance.

Adverse consequences of technostress in individuals include decreased well-being (Fuglseth & Sørebø, 2014), increased exhaustion (Maier, Laumer, & Eckhardt, 2015; Tarafdar et al., 2010), as well as physiological stress reactions such as the release of stress hormones and increased blood pressure (Fischer, Halmerbauer, Meyr, & Riedl, 2018; Tams, Hill, de Guinea, Thatcher, & Grover, 2014). In organizational settings, exposure to techno-stressors was related to decreased job commitment (Ahmad, Amin, & Ismail, 2012; Kumar, Lal, Bansal, & Sharma, 2013; Ragu-Nathan et al., 2008; Tarafdar et al., 2007), lower usage continuance intention (Fuglseth & Sørebø, 2014; Maier, Laumer, Weinert, et al., 2015), lower productivity (Hung, Chang, & Lin, 2011; Tarafdar et al., 2007), lower job performance (Tarafdar et al., 2015; Tarafdar et al., 2010), enhanced job stress (Hung et al., 2011), lower job satisfaction (Kumar et al., 2013; Ragu-Nathan et al., 2008; Tarafdar et al., 2007), increased risk of job burn-out, as well as decreased job engagement (Srivastava, Chandra, & Shirish, 2015). Considering the severity of these consequences for employees and organizations, it comes as a surprise that little research has focused on individual coping strategies to handle techno-stressors and consequently reduce technology-related strain. Furthermore, the few existing studies on coping with technostress used cross-sectional designs instead of evaluating long-term effects. However, coping is a dynamic process, which unfolds over time and, therefore, the aim of this study is to investigate mediating effects of coping over time.

In summary, technostress refers to the perception of threatening situations involving ICTs that may result in technology-related strain. This process is a contextual, dynamic process depending on individuals' resources and coping abilities. Feedback loops lead to reappraisal of the situation and potentially to modified coping behaviors. In the following section we delineate the role of age within the technostress framework.

## Age and Technostress

We rely on general aging theories to develop our hypotheses. We propose two opposing mechanisms, which influence the relationship between age and technostress. On the one hand, aging is connected to physical degeneration processes, such as cognitive decline (Salthouse, 1996, 2004), which make older adults more exposed to some techno-stressors but not to all (Tams, 2017). On the other hand, aging is connected to higher resilience, gaining a broader repertoire of coping strategies and increased competence in handling emotions (Diehl & Hay, 2010; Scheibe & Carstensen, 2010). We propose that such age-related gains lead to more efficient coping with techno-stressors and consequently decreased technology-related strain over time. In the following paragraphs we unfold these arguments and propose our hypotheses.

## The Relationship between Age and Techno-stressors

Cognitive theories on aging center on cognitive decline (e.g., working memory, processing speed) across the life span (Salthouse, 1996, 2004). Further, physical age-related degeneration processes include deterioration in hearing, vision and fine motor skills (Owsley, 2016; Reuter, Voelcker-Rehage, Vieluf, & Godde, 2012; Salthouse, 2014). All of these physical skills are required when using ICTs. For instance, age effects on technostress might arise from working memory decline, such as the capacity to process information needed to complete ICT-related tasks. Indeed, a meta-analysis on age and technology acceptance revealed that older adults report greater difficulties in handling technology compared to younger adults (Hauk et al., 2018). Two of the techno-stressors, namely techno-overload and techno-complexity, refer to situations specifically related to handling ICTs. Therefore, in these situations individuals' cognitive abilities and physical conditions are paramount to meeting technological demands. In contrast, the other three techno-stressors, namely techno-insecurity, techno-uncertainty, and techno-invasion, refer to situations in which cognitive abilities play a minor role in meeting ICT-related demands. Therefore, we do not expect all dimensions of technostress to be prone to age effects. On average, however, as people grow older and experience more difficulties in handling technology, situations related to ICT usage should be appraised as threatening more often by older as compared to younger individuals. We conclude that the relationship between age and the level of overall techno-stressors should be positive due to physical age-related decline. We therefore hypothesize:

*H1: Age is positively correlated to techno-stressors.*

So far, empirical evidence on the relationship between age and techno-stressors has been mixed. In line with our theorizing are results of one study in which age was positively correlated with techno-overload and techno-complexity, but not correlated with techno-invasion, techno-insecurity and techno-uncertainty (Tu, Wang, & Shu, 2005). Furthermore, most studies report that age is a significant positive predictor of how employees perceive the overall level of techno-stressors (Fuglseth & Sørebø, 2014; Shu, Tu, & Wang, 2011; Tu et al., 2005; Wang, Shu, & Tu, 2008). However, one study reports that the experience of techno-stressors decreases as age increases (Ragu-Nathan et al., 2008). In sum, however, those studies included age merely as a control variable and lack sufficient theoretical foundation. Moreover, most of the samples did not include age-ranges comparable to a representative working population and consist of only a small proportion of older workers (Tu et al., 2005;

Wang et al., 2008). Therefore, hitherto presented empirical evidence on age effects should be treated with caution.

**The Relationship between Age and Coping**

Life-span theory of control suggests that the use of primary control strategies increases with age until it declines after retirement, for example, at 65 years and older (Heckhausen et al., 2010). Primary control refers to changing the immediate environment and therefore relates to active problem-solving behavior (Heckhausen & Schulz, 1995; Lazarus & Folkman, 1987). Thus, according to life-span theory of control chronological age should be connected to an increase in both active coping as well as seeking instrumental social support throughout work-life. Furthermore, theories on life-span development suggest that aging is connected to gaining “situational, strategic, and procedural knowledge about emotional situations” (Scheibe & Carstensen, 2010), as well as accumulating knowledge about and experience with challenging situations (Baltes, Staudinger, & Lindenberger, 1999; Blanchard-Fields, 2007). These gains in internal resources enable individuals across the life-span to adopt problem-solving strategies that are more context-specific and more adaptive (Blanchard-Fields, 2007; Scheibe & Carstensen, 2010). Hence, older adults avail of a broader repertoire of coping strategies when it comes to facing challenges (Aldwin & Levenson, 2001; Baltes et al., 1999; Carstensen, 2006; Scheibe & Carstensen, 2010). Moreover, according to socioemotional selectivity theory emotionally gratifying experiences gain importance in case lifetime is perceived as increasingly limited, which naturally is the case when aging (Carstensen, 2006; Weikamp & Göritz, 2016). This shift towards mood-enhancement goals should further increase the motivation to engage in successful coping in older adults. Summing up, age effects in coping decisions are based on shifts in norms, motifs, emotional goals and behavioral strategies across adulthood (Scheibe & Carstensen, 2010).

Even though coping options seem to be highly situational, the coping strategies active coping, seeking instrumental social support, and behavioral disengagement are among the most prevalent coping strategies in the occupational technostress context (Ortiz de Guinea, 2016). Therefore, we will focus our hypotheses on these three strategies.

Active coping includes taking direct action as well as increasing efforts to address a stressful situation (Charles S Carver, Michael F Scheier, & Jagdish Kumari Weintraub, 1989a). Hence, active coping requires high motivation, pronounced problem-solving skills, as well as task-related knowledge – all of which are more pronounced with increasing age. Furthermore, empirical evidence suggests that older employees use more active coping when confronted with work related stress compared to their younger colleagues (G. Hertel, Rauschenbach, Thielgen, & Krumm, 2015). Therefore, we hypothesize:

*H2a: Age is positively correlated with active coping.*

We propose that the ability to seek instrumental social support depends on a person's capacity to interact with their social environment. More precisely, seeking instrumental social support involves asking for advice, seeking assistance, and gather information from others (Carver et al., 1989a). Therefore, seeking instrumental social support depends on organizational interconnectedness, as well as on social and communication skills. Previous research has shown that aging is connected to gaining social skills, for example, being more sensitive to emotional cues when making social inference (Hess, Osowski, & Leclerc, 2005), and being more competent in managing social interactions (Blanchard-Fields, 2007). Hence, being able to build good interpersonal relationships with colleagues, supervisors, and experts in organizations might be easier for older workers compared to younger workers. Being able to rely on a pronounced social network provides the basis for engaging in social coping, for example, asking someone knowledgeable for help.

Furthermore, personality traits influence behavioral reactions to stressful events such as coping mechanisms (Bolger, 1990; Srivastava et al., 2015). We argue that older workers rely on social coping more extensively than younger workers due to personality development. Research on personality development over the lifespan suggests that older individuals are more emotionally stable, agreeable, and conscientious (Specht, Egloff, & Schmukle, 2011). Individuals with high levels in agreeableness are described as kind, considerate, likable and cooperative (Graziano & Eisenberg, 1997), have a communal orientation (Zellars & Perrewé, 2001), are friendly, helpful, and empathetic (John & Srivastava, 1999). Hence, individuals high in agreeableness might be more willing to be guided and more accepting of support by others. Therefore, we hypothesize:

*H2b: Age is positively correlated with seeking instrumental social support.*

Behavioral disengagement includes reducing the amount of effort and giving up the attempt to change a stressful situation (Carver et al., 1989a). Withdrawal from a conflict might be wise in interpersonal situations and is therefore considered a social skill, which is more often used by older as compared to younger adults (Blanchard-Fields, 2007; S. T. Charles & Piazza, 2009). However, while avoiding a stressor might be adaptive in interpersonal conflicts, avoidance is not an effective strategy when faced with techno-stressors. Insights drawn from personality psychology suggest that the average level of conscientiousness increases over the life-span (Specht et al., 2011). Conscientiousness is reflected in individual behaviors such as being organized, tidy, reliable, and responsible (Carver & Connor-Smith, 2010). The planful, disciplined part of the conscientiousness trait make disengagement less likely (Carver & Connor-Smith, 2010). Hence, increasing levels of conscientiousness might influence secondary appraisal processes such as the evaluation of appropriate coping strategies in the face of stressors. Indeed, empirical findings suggest that individuals with lower levels in responsibility were less likely to use instrumental coping and more likely to use avoidance (Aldwin, 1991). We argue that older workers will less often disengage from techno-stressors in occupational settings due to acting responsibly and feeling obliged to their duty. Moreover, behavioral disengagement is more often used in case problem-orientated coping is not available (Carver et al., 1989a). However, since aging is connected to gaining a broader variety of coping strategies, older workers might less often have to opt for alternative coping strategies. According to previous research the use of functional coping strategies increases during adulthood, whereas the use of dysfunctional coping strategies decreases when faced with daily stressors (Diehl et al., 2014). Consequently, we propose that older workers use less behavioral disengagement than younger workers, when confronted with technostress at work due to higher conscientiousness. Corroborating findings suggest that older adults use more problem-focused coping when faced with instrumental problems and use more avoidant, denial coping when faced with interpersonal problems (Blanchard-Fields, Mienaltowski, & Seay, 2007). Therefore, we hypothesize:

*H2c: Age is negatively correlated with behavioral disengagement.*

**The Relationship between Age and Technology-related Strain**

Most studies published so far have examined antecedents of technostress as well as work-related outcomes, such as productivity. Studies on adverse psychological outcomes like technology-related strain are few and their results with regard to age are somewhat unclear (Day, Paquet, Scott, & Hambley, 2012; Korpinen & Pääkkönen, 2011; Seppala, 2001). Nevertheless, a systematic review on the relationship between ICT-use and health outcomes concludes that older employees do not experience more stress or burnout than their younger colleagues when using ICT (Berg-Beckhoff, Nielsen, & Ladekjær Larsen, 2017). However, none of the studies included in the review explicitly formulated age-specific hypotheses.

Insights drawn from work and organizational psychology research suggest that older workers experience lower levels of emotional exhaustion than younger workers (Ng & Feldman, 2010) and that perceived strain levels at work decline with age (Rauschenbach, Krumm, Thielgen, & Hertel, 2013). According to life-span theory of control, aging is connected to an increase in secondary control strategies across the entire life-span, for example, cognitive coping strategies aimed at changing internal processes (Heckhausen & Schulz, 1995; Heckhausen et al., 2010). Accordingly, aging is connected to increasing self-regulation skills. Moreover, as people age they become more skilled in handling negative emotions (Blanchard-Fields, 2007) and have a stronger focus on positive stimuli and emotional well-being (Baltes et al., 1999; Carstensen, 2006). In addition, aging is connected to higher resilience to certain stressors (Aldwin & Levenson, 2001; MacLeod, Musich, Hawkins, Alsgaard, & Wicker, 2016). Higher self-regulation skills, more positive appraisals and higher resilience might explain why older adults report less technology-related strain at work. Therefore, we propose that even though reactivity to stressors is immanent for all age groups, this association is less immanent for older adults (Diehl & Hay, 2010). Therefore, we hypothesize:

*H3: Age is negatively correlated with technology-related strain.*

Moreover, we specifically suggest that coping strategies determine the level of technology-related strain that workers experience. Coping mechanisms are critical for outcomes such as psychological well-being (Diehl et al., 2014). Presumably, the lower level of work stress and technology-related strain is due to a higher competence in handling stressors. For example, the use of more active coping was revealed as explanatory variable in the age-strain relationship in the work context (G. Hertel et al., 2015). This notion is substantiated by research revealing that coping processes explain differences in work-exhaustion as a consequence of techno-stressors (Fulvio Gaudioso et al., 2017). Specifically, when dealing with techno-stressors problem-focused coping reduces work-exhaustion, whereas disengaging and ignoring increase work exhaustion (Fulvio Gaudioso et al., 2017). As proposed earlier, we suggest that on average older workers engage more in functional coping and less in dysfunctional coping. Furthermore, we propose that higher usage of functional coping leads to lower ICT-related strain over time, whereas higher usage of dysfunctional coping increases ICT-related strain over time. Finally, we suggest that coping style differences function as a buffer between age-related increases in techno-stressors, and explain age effects on perceived technology-related strain. Therefore, we hypothesize:

*H3a: The correlation between age and technology-related strain is mediated through techno-stressors and functional coping (active and social coping).*

*H3b: The correlation between age and technology-related strain is mediated through techno-stressors and dysfunctional coping (behavioral disengagement).*

## Method

### Participants and Procedure

We conducted a web-based study through the online panel WiSoPanel (Göritz, 2014) that comprises members from German speaking countries (Germany, Austria and Switzerland). Data were collected at three time points (i.e., $t_1$, $t_2$, $t_3$), each separated by four months. The criterion for participation was being regularly employed at all measurement points. In total, $N_{t1}$ = 1,216 professionals completed the survey at the first measurement point, $N_{t2}$ = 840 professionals responded again at the second measurement point, and $N_{t3}$ = 631 professionals participated in all three measurement points. The mean age of the sample was 46.3 years (*SD* = 10.7), ranging from 17 to 75 years, and 55.2% of the participants were female. Participants were well educated: Half of the participants finished O-Levels or A-Levels (51.1%), and 40.4% had completed a university degree or higher, whereas 8.5% of the participants had no educational degree. Many participants worked in companies with more than 250 employees (*N* = 570, 46.9%), whereas 22.3% (*N* = 271) worked in companies with up to 250 employees, and 30.8% (*N* = 375) worked in companies up to 50 employees. More than 50% had worked in their company for more than 10 years, and 76.5% had received at least one ICT-related training so far. All participants received monetary compensation for completing the questionnaire at each measurement point.

**Measures**

***Techno-stressors.*** Technostress at the workplace was measured with 23 items published in Tarafdar, Tu, Ragu-Nathan, and Ragu-Nathan (Tarafdar et al., 2007). The items cover five techno-stressors: (1) techno-overload defined as the feeling of being pressured to work faster and longer due to the implementation of ICT, for example, *"I am forced by this technology to work much faster."* (2) techno-invasion defined as permanent availability due to ICT usage, for example, *"I feel my personal life is being invaded by this technology."* (3) techno-complexity defined as the feeling of incompetence in the face of ICT, for example, *"I need a long time to understand and use new technologies."* (4) techno-insecurity defined as the feeling of being replaceable due technological innovation, for example, *"I am threatened by coworkers with newer technology skills."* and (5) techno-uncertainty defined as the feeling that ICT is constantly changing, for example, *"There are constant changes in computer software in our organization."* All items were measured on a Likert scale from 1 (never) to 5 (always). The scale showed high reliability across measurement points ($\alpha$ = .94 to .95; cf. S1).

***ICT-related coping.*** ICT-related coping behavior was measured using three scales (active coping, seeking instrumental social support, behavioral disengagement) adapted from Carver, Scheier, and Weintraub (Carver et al., 1989a). To adjust the items to the ICT context we used the following instruction: "*Indicate to which extent your thoughts and actions correspond to the following statements about difficult or unpleasant situations handling ICT at work in the past*." Ratings were given on a Likert scale from 1 (*never*) to 4 (*always*). Active coping was measured with 4 items, for example, "*I concentrate my efforts on doing something about it.*" Seeking instrumental social support was measured with 4 items, for example, "*I try to get advice from someone about what to do.*" Behavioral disengagement was measured with 4 items, for example, "*I admit to myself that I can´t deal with it and quit* *trying*.” Each scale showed high reliability across measurement points (α = .87 to .91; cf. S1). For practical reasons, we will subsequently use the term social coping when referring to seeking instrumental social support.

***ICT-related strain.*** ICT-related strain, such as physical and emotional exhaustion, was measured as the degree to which an employee felt strained due to ICT usage in connection to work tasks. We used a 5-item scale adapted from Moore (Ayyagari, Grover, & Purvis, 2011; Moore, 2000) including items such as “*I feel emotionally drained from ICT use at work*.” or “*I feel fatigued from work assignments, which involve the application of ICT*.” Items were rated on a Likert scale from 1 (*never*) to 7 (*always*). The scale showed high reliability across measurement points (α = .95 to .97; cf. S1).

***Control variables.*** Research has shown that experience of ICT-related strain is not limited to any specific occupation (Ayyagari et al., 2011). Yet, ICT usage varies across different occupations (Maier, Laumer, & Eckhardt, 2015). Since higher technology dependence of an employee is associated with higher level of technostress (Shu et al., 2011), we included ICT-dependency on work related tasks as a control variable. ICT-dependency was measured with a 7-item scale (Shu et al., 2011), for example, “*It would be difficult to imagine my work without a computer*.” or “*All of knowledge sharing and information transferring are carried out by internet or intranet in my organization*.” The statements were rated on a Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The scale exhibited high internal consistency across measurement points (α = .89 to .92; cf. S1).

## Analysis Procedure

We used multilevel modeling (MLM) to account for data dependency due to repeated measurement in our longitudinal study. Moreover, MLM has the advantage of exploiting all valid data points in the analysis, therefore, minimizing data loss due to attrition in longitudinal studies (Singer & Willett, 2003). We fitted three separate multilevel mediation models with two serial mediators each using Mplus version 7.1 (Muthén & Muthén, 2013). Age was entered as the level-2 predictor (X), techno-stressors (M1) and one coping strategy per model (M2) as level-1 mediators and technology-related strain (Y) as the level-1 outcome (cf. Fig 1). MLM within-level effects refer to individual change over time, for example, how technology-related strain changes across measurement points as a function of coping. Between-level effects refer to inter-individual differences of these relationships, for example, how these processes differ across individuals of different ages.

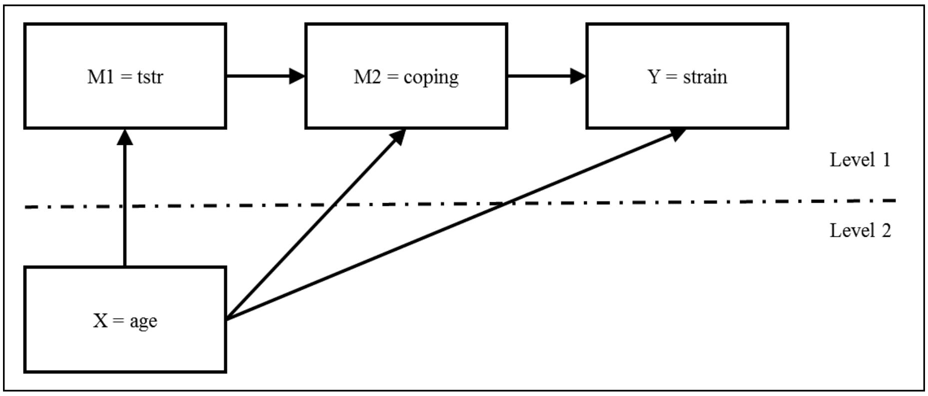


*Figure 3.1.* Research Model. We additionally considered ICT dependency as a control variable in the model by including the direct effect of ICT dependency on all variables.

***Add-on analysis.*** We tested spiral effects – the specific temporal order of coping behavior and technology-related strain – using the SPSS PROCESS macro (Hayes, 2013). We conducted two separate serial mediation analyses with different starting points. First, we entered age as the predictor variable (X), technology-related strain at t1 as the first mediator ($M1_{t1}$), coping strategies at t2 as the second mediator ($M2_{t2}$) and technology-related strain at t3 as the outcome ($Y_{t3}$). Second, we entered age as the predictor variable (X), coping strategies at t1 as the first mediator ($M1_{t1}$), technology-related strain at t2 as the second mediator ($M2_{t2}$) and coping strategies at t3 as the outcome ($Y_{t3}$). We controlled for ICT-dependency at t1 in both models.

## Results

Hypothesis 1 posited that chronological age and the level of overall techno-stressors are positively related. Contrary to our hypothesis, age was negatively related to technostress at $t_2$ ($r_{t2}$ = -.10), and not related to technostress at $t_1$ and $t_3$ ($r_{t1}$ = -.05, $r_{t3}$ = -.06; cf. S1). Furthermore, multilevel mediation analysis yielded a significant negative total effect (β = -.07 [-.13; -.02], $p < .05$; cf. Table 1), though the effect of age on the level of overall techno-stressors was not significant (β = -.04 [-.09; .01], $p = .224$; cf. Table 1) when controlled for ICT dependency. Thus, Hypothesis 1 was not supported.

Table 3.1. MLM results on age and techno-stressors.

| **Outcome: tstr** | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.037 | .031 | .226 | -.088 | .013 | .126 | <.001 |
| dep | .349 | .029 | .000 | .300 | .396 | | |

**Total Effect**

| **age to tstr** | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.073 | .032 | .023 | -.125 | -.020 |

*Note.* Standardized model results, *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/UL = 95% lower-level and upper-level confidence interval, tsrt = techno-stressors, dep = ICT dependency

Hypothesis 2a stated that chronological age and the use of active coping are positively related. Contrary to our hypothesis, age was negatively related to active coping at t1 ($r_{t1}$ = -.10) and not related to active coping at t2 and t3 ($r_{t2}$ = -.02, $r_{t3}$ = -.02; cf. S1). Drawing on the multilevel mediation results, there was a small, yet significant negative total effect of age on active coping (β = -.09 [-.14; -.04], $p < .05$; cf. Table 2). However, the direct effect of age on active coping was not significant when the level of techno-stressors and ICT dependency were controlled for (β = -.03 [-.01; .02], $p$ = .286; cf. Table 2). Hence, active coping was not related to age. Thus, Hypothesis 2a was not supported.

Table 3.2. MLM results on age and active coping.

| **Outcome: active** | Estimate | SE | $p$ | LL | UL | $R^2$ | $p$ |
|---|---|---|---|---|---|---|---|
| age | -.030 | .029 | .286 | -.077 | .017 | .339 | <.001 |
| tstr | .020 | .036 | .568 | -.038 | .079 | | |
| dep | .571 | .035 | .000 | .514 | .628 | | |

**Total Effect**

| **age to active** | Estimate | SE | $p$ | LL | UL |
|---|---|---|---|---|---|
| total | -.090 | .032 | .006 | -.143 | -.037 |

*Note.* Standardized model results, $N$ = 1,216, SE = standard error, $p$ = two-tailed $p$-value, LL/ UL = 95% lower-level and upper-level confidence interval, tstr = techno-stressors, dep = ICT dependency

Hypothesis 2b stated that chronological age and the use of social coping are positively related. Opposed to our hypothesis, chronological age was negatively related to social coping at t1 and t2 ($r_{t1}$ = -.13, $r_{t2}$ = -.07) but not at t3 ($r_{t3}$ = -.05; cf. S1). Drawing on the multilevel mediation results, there was a significant negative total effect of age on social coping (β = -.14 [-.20; -.09], $p$ < .05; cf. Table 3). Furthermore, the direct effect of age on social coping was significant when the level of techno-stressors and ICT dependency were controlled for (β = -.09 [-.14; -.04], $p$ < .01; cf. Table 3). Hence, as age increased social coping decreased. Hypothesis 2b was not supported.

Table 3.3. MLM results on age and social coping.

| **Outcome: social** | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.087 | .030 | .003 | -.137 | -.038 | .284 | <.001 |
| tstr | .168 | .035 | .000 | .110 | .225 | | |
| dep | .433 | .035 | .000 | .376 | .490 | | |

**Total Effect**

| **age to social** | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.144 | .032 | .000 | -.197 | -.090 |

*Note.* Standardized model results, *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/UL = 95% lower-level and upper-level confidence interval, tstr = techno-stressors, dep = ICT dependency

Hypothesis 2c posited that chronological age and the use of dysfunctional coping, for example, behavioral disengagement, are negatively related. In line with this hypothesis, we found a significant negative correlation between age and behavioral disengagement at all measurement points ($r_{t1}$ = -.10, $r_{t2}$ = -.14, $r_{t3}$ = -.14; cf. S1). This was further supported by the multilevel mediation analysis, which yielded a significant total effect (β = -.15 [-.21; -.10], $p < .001$; cf. Table 4), as well as a significant direct effect (β = -.11 [-.16; -.07], $p < .001$; cf. Table 4) controlled for the level of techno-stressors and ICT dependency. Hence, as age increased behavioral disengagement decreased. Thus, Hypothesis 2c was supported.

Table 3.4. MLM results on age and behavioral disengagement.

| **Outcome: diseng** | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.114 | .026 | .000 | -.156 | -.072 | .569 | <.001 |
| tstr | .782 | .025 | .000 | .741 | .823 | | |
| dep | -.168 | .030 | .000 | -.217 | -.119 | | |

**Total Effect**

| **age to diseng** | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.153 | .034 | .000 | -.210 | -.097 |

*Note.* Standardized model results, *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/UL = 95% lower-level and upper-level confidence interval, tstr = techno-stressors, dep = ICT dependency

Hypothesis 3 stated that chronological age and technology-related strain are negatively related. In line with this hypothesis, there was a significant negative correlation between age and technology-related strain at all three measurement points ($r_{t1}$ = -.08, $r_{t2}$ = -.14, $r_{t3}$ = -.13; cf. S1). Furthermore, results of the multilevel mediation analysis indicated a significant negative total effect of age on technology-related strain (β = -.12 [-.18; -.07], $p$ < .05). Hence, as age increased technology-related strain decreased. Hypothesis 3 was supported.

Hypothesis 3a posited that functional coping, such as active problem solving and social coping, mediates the negative relationship between chronological age and technology-related strain. Opposed to this hypothesis, there neither was a significant indirect effect of age on technology-related strain via active coping (β = -.00 [-.00; .00], $p$ = .753; cf. Table 5), nor via techno-stressors (β = -.03 [-.09; .01], $p$ = .224; cf. Table 5), nor via both mediators (β = .00 [.00; .00], $p$ = .748; cf. Table 5). Hence, we found no evidence that active coping is a resolving link in the relationship between age and technology-related strain as already indicated through the non-significant bivariate correlations at t2 and t3 (cf. S1).

Furthermore, there neither was a significant indirect effect of age on technology-related strain via social coping (β = -.00 [-.01; .00], $p$ = .394; cf. Table 6), nor via techno-stressors (β= -.03 [-.09; .01], $p$ = .222; cf. Table 6), nor via both mediators (β = .00 [.00; .00], $p$ = .447; cf. Table 6). Hence, there was no evidence that social coping explains the relationship between age and technology-related strain. Thus, Hypothesis 3a was not supported.

Table 3.5. Age effects on technology-related strain via techno-stressors and active coping.

| **Outcome: strain** | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.068 | .024 | .004 | -.106 | -.029 | .618 | <.001 |
| tstr | .790 | .021 | .000 | .756 | .824 | | |
| active | .012 | .036 | .742 | -.048 | .072 | | |
| dep | -.043 | .033 | .200 | -.097 | .012 | | |

**Total, Direct and Indirect Effects**

| **age to strain** | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.122 | .033 | .000 | -.176 | -.068 |
| total indirect | -.054 | .025 | .029 | -.095 | -.013 |
| via tstr | -.029 | .024 | .224 | -.069 | .010 |
| via active | .000 | .001 | .753 | -.002 | .002 |
| via tstr and active | .000 | .000 | .748 | .000 | .000 |
| direct effect | -.068 | .024 | .004 | -.106 | -.029 |

*Note.* Standardized model results, *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/UL = 95% lower-level and upper-level confidence interval, active = active coping, tstr = techno-stressors, dep = ICT dependency

Table 3.6. Age effects on technology-related strain via techno-stressors and social coping.

| **outcome: strain** | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.065 | .024 | .006 | -.104 | -.026 | .618 | <.001 |
| tstr | .785 | .021 | .000 | .750 | .820 | | |
| social | .030 | .033 | .372 | -.025 | .084 | | |
| dep | -.049 | .029 | .097 | -.049 | .000 | | |

**Total, Direct and Indirect Effects**

| **age to strain** | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.122 | .033 | .000 | -.176 | -.068 |
| total indirect | -.057 | .025 | .022 | -.097 | .016 |
| via tstr | -.029 | .024 | .222 | -.069 | .010 |
| via social | -.003 | .003 | .394 | -.008 | .002 |
| via tstr and social | .000 | .000 | .447 | -.001 | .000 |
| direct | -.065 | .024 | .006 | -.104 | -.026 |

*Note.* Standardized model results, *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/UL = 95% lower-level and upper-level confidence interval, social = social coping, tstr = techno-stressors, dep = ICT dependency

Hypothesis 3b stated that chronological age leads to less dysfunctional coping, which in turn leads to less technology-related strain. In line with this hypothesis, there was a significant indirect effect of age on technology-related strain via behavioral disengagement (β = -.04 [-.06, -.02], $p < .001$; cf. Table 7), but neither via techno-stressors (β = -.02 [-.05, -.01], $p = .226$; cf. Table 7), nor via both mediators (β = -.01 [-.02, .00], $p = .245$; cf. Table 7). Interestingly, the direct path from of age onto technology-related strain was not significant anymore (β = -.03 [-.07; .01], $p = .175$; cf. Table 7) when taking indirect effects into account. This indicates full mediation of the relationship between age and technology-related strain through behavioral disengagement. Hypothesis 3b was supported.

Table 3.7. Age effects on technology-related strain via techno-stressors and behavioral disengagement.

| **outcome: strain** | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.030 | .022 | .175 | -.067 | .007 | .665 | .000 |
| tstr | .531 | .050 | .000 | .449 | .613 | | |
| diseng | .331 | .055 | .000 | .241 | .421 | | |
| dep | .021 | .024 | .380 | -.018 | .059 | | |

**Total, Direct and Indirect Effects**

| **age to strain** | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.122 | .033 | .000 | -.176 | -.068 |
| total indirect | -.091 | .027 | .001 | -.136 | -.046 |
| via tstr | -.020 | .016 | .226 | -.046 | .007 |
| via diseng | -.038 | .011 | .000 | -.055 | -.020 |
| via tstr and diseng | -.010 | .008 | .245 | -.023 | .004 |
| direct | -.030 | .022 | .175 | -.067 | .007 |

*Note.* Standardized model results, $N = 1{,}216$, SE = standard error, $p$ = two-tailed $p$-value, LL/UL = 95% lower-level and upper-level confidence interval, diseng = behavioral disengagement, tstr = techno-stressors, dep = ICT dependency

To sum up, age effects were driven through negative direct effects of age on behavioral disengagement (β = -.11 [-.17; -.07], $p < .001$; cf. Table 4). Hence, the negative linkage between age and behavioral disengagement buffered the otherwise amplification of the stress process from techno-stressors to increasing behavioral disengagement (β = .78 [.74;

.82], $p < .001$; cf. Table 4), and from behavioral disengagement to increasing technology-related strain (β = .33 [.24; .42], $p < .001$; cf. Table 7, Fig 2).

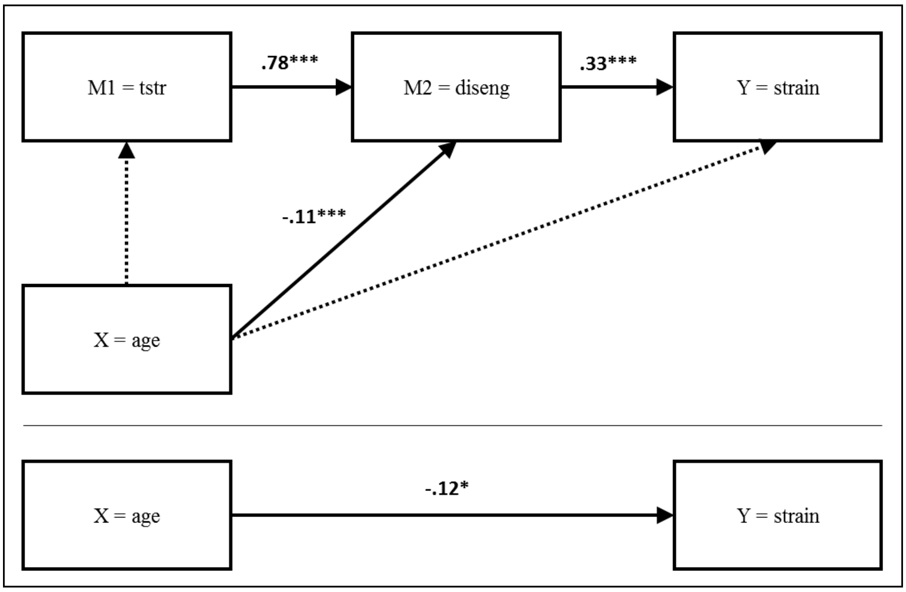


*Figure 3.2.* Model with Behavioral Disengagement. Standardized path coefficients are given in S4; the dotted lines indicate non-significant effects; ICT dep was considered as a control variable in the model by including the direct effect of ICT dep on all variables.

Furthermore, within-level effects reflect the development of the technostress process over time: The positive relationship between techno-stressors and technology-related strain (β = .30 [.24; .36], $p < .001$) was partly mediated through active coping (β = .01 [.00; .01], $p < .05$), social coping (β = .01 [.00; .02], $p < .05$; cf. Table 4), as well as behavioral disengagement (β = .03 [.02; .05], $p < .001$; cf. Table 5). Hence, coping strategies partially explain the development of the stress process from techno-stressors to technology-related strain over time. Specifically, engagement in any coping activity enhanced the technology-related strain level across measurement points.

Table 3.8. Coping Effects on Technology-related Strain Over Time.

| | | Total, Direct and Indirect Effects | | | | |
|---|---|---|---|---|---|---|
| **trs to strain** | | Estimate | SE | *p* | LL | UL |
| total | | .299 | .034 | .000 | .244 | .355 |
| A | direct | .292 | .034 | .000 | .237 | .347 |
| | via active | .007 | .004 | .035 | .002 | .013 |
| B | direct | .290 | .034 | .000 | .235 | .346 |
| | via social | .009 | .004 | .025 | .003 | .016 |
| C | direct | .266 | .032 | .000 | .213 | .319 |
| | via diseng | .033 | .010 | .001 | .017 | .049 |

*Note.* Standardized model results, A = mediation model with active coping as mediator, B = mediation model with social coping as mediator, C = mediation model with behavioral disengagement as mediator, SE = standard error, *p* = two-tailed *p*-value, LL/ UL = 95% lower-level and upper-level confidence interval, active = active coping, social = social coping, diseng = behavioral disengagement, tstr = techno-stressors, strain = technology-related strain

**Add-on Analysis.** To test spiral effects of behavioral disengagement and technology-related strain we tested two separate serial mediation models with different starting points. The first model assumed that technology strain at t1 and behavioral disengagement at t2 mediate the relationship between age and technology strain at t3. The indirect effect of age on technology strain at t3 via both mediators (age → strain $t_1$ → diseng $t_2$ → strain $t_3$) was not significant (β = -.001, 95 % CI [-.002; .000]; cf. S5).

The second model assumed that behavioral disengagement at t1 and technology strain at t2 mediate the relationship between age and behavioral disengagement at t3. Indeed, the indirect effect of age on behavioral disengagement at t3 via both mediators (age → diseng $t_1$ → strain $t_2$ → diseng $t_3$) was significant (β = -.001, 95 % CI [-.002; -.000]; cf. S5).

To sum up, the age effect on the development of the stress process seems to be a spiral effect within which behavioral disengagement not only leads to increased technology-related strain, but technology-related strain leads to increased behavioral disengagement, as well.

**Discussion**

The goal of this longitudinal study was to evaluate how workers across the age-span cope with technostress in a digitalized work environment. Specifically, we conducted a series of multi-level mediation analyses to evaluate longer-term effects of coping on technology-related strain as well as age effects on the technostress process.

We found that older workers reported a lower level of ICT-related strain. Moreover, older workers engaged in less problem-focused coping as well as in less behavioral disengagement, as indicated by negative total effects of age on active coping, social coping, and behavioral disengagement. Furthermore, any coping behaviors in response to technostress increased technology related strain over time. The negative relationship between workers' age and their technology-related strain was explained through less behavioral disengagement with increasing age, and not through more active or social coping. Additionally, spiral effects of age on technology-related strain and coping indicated that behavioral disengagement led to increased technology-related strain and, subsequently, technology-related strain led to increased behavioral disengagement. Finally, there was no significant relationship between age and the level of techno-stressors, provided that job-related ICT dependency is controlled for. Therefore, in occupational settings higher age is not per se connected to increased prevalence of situations in which ICT-related demands exceed workers' abilities to meet them.

The present study extends earlier work in several ways. First, most studies so far have added age merely as a control variable to their model and lack theoretical underpinnings on the role of age (Ragu-Nathan et al., 2008; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2011; Wang et al., 2008). That is why we built on general aging theories to provide a so far missing theoretical foundation on the role of age and age-contingent coping in the technostress process. Second, little research has focused on individual coping strategies to handle techno-stressors and consequently reduce technology-related strain. Third, we extend earlier work by choosing a broad time window to examine the dynamic processes of technostress and coping instead of relying on cross-sectional data. Fourth, most previous studies on technostress in occupational settings have focused on specific occupational groups (Moore, 2000). However, to understand the general mechanisms of ICT-related strain at work, our sample consists of workers from various professions. Fifth, unlike previous studies, our sample covers a complete age span of workers, including workers of higher age.

**Theoretical Implications**

The results of our study have several implications. First, the relationship between age and techno-stressors may be more complex than previously thought. While we built our theorizing on age-related cognitive and physical decline and argued that age would be positively related to techno-stressors (Fuglseth & Sørebø, 2014; Shu et al., 2011; Tu et al., 2005; Wang et al., 2008), older and younger individuals in fact experience a similar amount of stressful situations connected to ICT use in their work-life. Since we controlled for ICT dependency, similar levels of subjective creation of technostress cannot be due to older workers' reduced exposure to technology. Notably, technostress does not only occur when actually handling ICTs, but also because of ICT-related feelings of uncertainty, insecurity and invasion of private life. These dimensions might be less strongly related to age than the actual handling of ICTs. For example, the techno-stressor insecurity – the fear of losing one's job due to ICTs – might even be appraised as less threatening as workers are approaching retirement age (Carstensen, 2006). Furthermore, greater work-related knowledge and experience might enable older workers to appraise situations related to uncertainty and invasion of private life as less threatening. Rauschenbach and colleagues (Rauschenbach et al., 2013) showed that the perception of work-related demands depends on the particularities of the situation. For example, if the demanding situation requires crystallized knowledge and experience, older workers may be in advantage compared to younger workers. Therefore, negative and positive age effects on the separate techno-stressors might level each other out. Consequently, the overall level of techno-stressors might be unrelated to age.

Second, our results do not fully comply with common considerations of the effectiveness of coping strategies. On the one hand, in line with our findings, ongoing behavioral disengagement increases the level of technology-related strain over time (Carver et al., 1989b). On the other hand, opposed to our hypotheses, the results indicate that ongoing active coping and social coping subsequently increase technology-related strain as well. Despite being considered *functional* coping strategies, it seems that engaging in problem-focused coping over a longer period of time (in our case eight months) increases the technology-related strain. One implication may be that a differentiation is needed between coping with momentary stressors that can actively be addressed and diminished on the one hand, and longer-lasting stressors that have an ongoing impact on one’s life. Indeed, the need to maintain coping activities over a longer stretch of time might draw on individual resources, require mental effort and energy, and consequently increase rather than reduce experienced strain.

Third, according to our findings there is no direct relationship between age and ICT-related active coping and a negative direct relationship between age and ICT-related social coping. One implication is that coping-related age trajectories (Diehl et al., 2014) may not generalize to several domains of coping. Possibly, the assumption of general age-related gains in coping competencies (Aldwin & Levenson, 2001; Baltes et al., 1999; Carstensen, 2006; Scheibe & Carstensen, 2010), must be viewed in a more differentiated manner to suit the technostress domain. For example, age-related gains in internal resources, such as knowledge about and experience with emotional situations (Scheibe & Carstensen, 2010), might not be specific enough when it comes to handling instrumental problems. Behavior enabling active problem-solving, for example, trying to control the stressful situation and doing what needs to be done, require specific task-related knowledge. ICT-related knowledge gains, however, might be unrelated to age and, therefore, active coping with techno-stressors might not be associated with age.

Another possible explanation might be found in the energy-conservation model by Aldwin and Levenson (Aldwin & Levenson, 2001), which seeks to explain age-differences in coping strategies. Accordingly, younger adults have more energy to spend than older adults and, therefore, engage more in problem-focused coping. Due to a shortage of experience, however, they are not necessarily more efficacious in doing so than older adults. Older adults, by contrast, have greater knowledge about which strategies are efficacious. To use their energy sparingly, older adults avoid ineffective coping activities. Thus, age is related to a decreased level of coping. However, despite coping less, older adults do not loose effectivity in the ability to cope. In fact, research suggests that older adults engage less in coping strategies than younger adults, however, older adults still remain more effective in coping than younger adults (Aldwin, 1991; Aldwin & Levenson, 2001). Following this notion, workers' age might be a negative direct predictor of the extent of coping, for example, seeking instrumental social support.

Fourth, results of our study imply that age-related gains in dealing with technostress are driven through decreased dysfunctional coping, rather than through increased functional coping. One might argue that the reason for lower levels of behavioral disengagement is that the average level of conscientiousness steadily increases over the life-span (Specht et al., 2011). Therefore, older workers less often disengage from techno-stressors due to the feeling of responsibility and obligation in occupational settings. Hence, increasing levels of conscientiousness influence the secondary appraisal in the evaluation of appropriate coping behaviors. Even though older workers engage in less functional coping compared to younger workers, they profit from decreased engagement in dysfunctional coping marked by lower technology-related strain. This notion is supported by previous studies suggesting that dysfunctional strategies have a stronger influence on adverse outcomes than functional coping (Fulvio Gaudioso et al., 2017).

Fifth, older workers are often confronted with negative stereotypes (B. I. v. d. H. Hertel, Annet H. de Lange, Jürgen Deller, Guido, Hertel, IJM van der Heijden, H. de Lange, & Deller, 2013; Rauschenbach, Göritz, & Hertel, 2012). For example, stereotypes in relation to technology use include the beliefs that information technology jobs are not considered appropriate for older workers, and that older workers are less willing to keep up with technology (Posthuma & Campion, 2008). However, our results contradict these stereotypes, by showing that i) age is unrelated to the amount of techno-stressors encountered during work-life and ii) the relationship between age and ICT-related strain is actually negative. Thus, older workers experience less ICT-related strain than younger workers. Similar conclusions have been drawn by the results of a meta-analysis on age and technology acceptance (Hauk et al., 2018). The authors suggest that the negative stereotype of technophobic older adults is unwarranted.

**Practical Implications**

Multiple studies demonstrated severe consequences of technostress for employees and organizations, for example, lower productivity (Hung et al., 2011; Tarafdar et al., 2007), lower job performance (Tarafdar et al., 2015; Tarafdar et al., 2010), increased work exhaustion (Maier, Laumer, & Eckhardt, 2015; Tarafdar et al., 2010), and increased risk of burn-out (Srivastava et al., 2015). Furthermore, technostress impacts the human body by triggering physical stress reactions such as the release of stress hormones and increased blood pressure (Fischer et al., 2018; Tams et al., 2014). Understanding the association between workers age and daily work-stressors, such as technostress, provides an avenue to develop preventive measures to lower the risk of age-related diseases, such as cardiovascular diseases. In particular, communicating effective and ineffective ways of coping as part of organizational measures could help improving health and maintain employees' well-being. Furthermore, our research shows that workers with higher IT-dependency are at greater risk of encountering techno-stressors. Therefore, preventive measures might be essential in occupations with heavy IT use.

**Future Research**

Further research might shed some light on the qualitative aspects of social coping. Our study suggest that i) extensive social coping increases technology-related strain over time and ii) older workers use less instrumental social support in the face of ICT-related stress. However, when it comes to examining age-related changes in stress and coping qualitative aspects of coping might be more revealing than the extent of coping. As previous research suggests, older adults remain as effective in coping as younger adults while coping less, regardless of the pattern of the used coping strategies (Aldwin, 1991; Aldwin & Levenson, 2001). Therefore, future studies should examine not only the extent of social coping, but rather the quality of social coping. One crucial component of seeking instrumental social support might be having access to the „right" person in the organization, such as an expert on ICT-related problems. Possibly, older workers profit from greater organizational knowledge and bigger work-related networks and, therefore, are more efficient in social coping. Furthermore, it could be revealing to examine social patterns of coping, that is, who is turning towards whom when seeking social support. For example, are older workers more likely to turn to peers, experts, or supervisors in comparison to younger workers?

Furthermore, other coping strategies than the ones examined in this study might be considered in future research. Studies suggest that emotion-focused coping increases in case individuals have limited control over the stressful situation (Folkman & Lazarus, 1980). This might especially hold true in occupational settings, in which the use of certain ICTs is mandatory (Beaudry & Pinsonneault, 2005). Furthermore, life-span theory of control suggests that the use of secondary control strategies, such as emotion regulation, increase throughout the life-span (S. Charles & Carstensen, 2010; Heckhausen & Schulz, 1995). Consequently, the negative relationship between age and technology-related strain might be due to internal emotion regulation processes. Two coping strategies, namely seeking emotional social support and cognitive reappraisal, could potentially contribute to handling ICT-related stressors in the work-context (Tarafdar, Cooper, & Stich, 2017). Both strategies strive to change the self in order to adjust to a stressful situation rather than changing the situation itself (Carver & Connor-Smith, 2010). Seeking emotional social support does so by obtaining emotional support and reassurance – instead of seeking instrumental help (Carver & Connor-Smith, 2010). Cognitive restructuring strives to change the self by changing the perception of the stressful situation, for example, by focusing on positive aspects of the situation (S. Charles & Carstensen, 2010). Additional socio-emotional coping behaviors, which have been suggested in the technostress context, are venting and co-rumination (Tarafdar et al., 2017).

Moreover, future research might consider age effects on techno-stressors in greater detail. As the theory section of this paper has suggested, age effects might be pertinent for some dimensions of technostress but not for others. We argued that age effects are driven through physical degeneration processes (Salthouse, 1996, 2004). However, our results showed no age effects on the level of overall techno-stressors. Examining the influence of age on the separate techno-stressors might extend our understanding of the role of age in the occupational technostress process.

Finally, future research might use alternative strain measures. For example, experience-based measures assess individuals' experiences in situ. Therefore, experience-based measures are less affected by generalized self-perceptions, social norms and stereotypical attitudes (Rauschenbach & Hertel, 2011). Furthermore, objective measures such as biological stress indicators might complement evidence based on self-reported data. Self-reports depend on appraisal processes and, therefore, might be biased through the decreased willingness of older workers to report psychological symptoms and negative emotions (Baltes et al., 1999; Scheibe & Carstensen, 2010). So far, there are few studies using objective stress measures in the technostress context, such as cardiovascular activity or levels of stress hormones. An overview on the biology of technostress can be found in Riedl (Riedl, 2013).

**Limitations**

This study is not without limitations. First, the longitudinal design of our study could be viewed as both an advantage and a limitation at the same time. Relatively long time-lags as in this study (4 months) allow for long-term investigation of workers' technostress, but are unsuited to capture daily experiences of workers. Therefore, our results are limited to mediate reactions to techno-stressors and coping reactions over time.

Second, we conducted a study about ICT-related strain by relying on the very medium ICT. We did so in order to incorporate a broad range of occupations and age groups through an online panel. However, workers with acute levels of technology-related strain are probably less likely to participate in surveys conducted through ICTs. Therefore, the results of our study could be biased through self-selection processes.

Third, further control variables could be included in the analyses. We included ICT-related dependency as a control variable. However, other variables that we did not assess in this study might be influential in the development of the technostress process as well. For example, a series of situational factors have been identified as stress inhibiting variables, such as provision of IT-support, organizational IT trainings, employee involvement in the facilitation of new ICTs (Ragu-Nathan et al., 2008; Tarafdar et al., 2015). These technostress inhibitors are thought to reduce the level of techno-stressors and, consequently, technology-related strain. Although situational factors within the organizational environment are expected to be unrelated to age, some studies found a negative relationship between age and technostress inhibitors (Fuglseth & Sørebø, 2014). Thus, technostress inhibitors might be considered a control variable.

## Conclusion

By conducting a longitudinal study on coping strategies within the age-technostress process, we revealed that age is negatively related to ICT-related sources of technostress as well as to ICT-related strain. The negative relationship between age and ICT-related strain was mediated through behavioral disengagement, which was more prevalent among younger than among older workers. Moreover, age was negatively related to the coping strategies active coping and seeking instrumental social support. In sum, the findings speak against the assumption that older workers are more prone to technology-related stress at work.

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## Supporting Information

### S1 Table. Correlation Matrix and Descriptive Statistics.

| | | | | | active | | | social | | | diseng | | | strain | | | tstr | | | dep | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | α | age | t1 | t2 | t3 | t1 | t2 | t3 | t1 | t2 | t3 | t1 | t2 | t3 | t1 | t2 | t3 | t1 | t2 |
| age | 46.29 | 10.65 | | | | | | | | | | | | | | | | | | | |
| t1active | 2.72 | .78 | .87 | -.101** | | | | | | | | | | | | | | | | | |
| t2active | 2.68 | .79 | .89 | -.018 | .548** | | | | | | | | | | | | | | | | |
| t3active | 2.67 | .80 | .88 | -.024 | .600** | .541** | | | | | | | | | | | | | | | |
| t1social | 2.57 | .81 | .90 | -.131** | .755** | .488** | .478** | | | | | | | | | | | | | | |
| t2social | 2.53 | .80 | .89 | -.072* | .481** | .767** | .456** | .597** | | | | | | | | | | | | | |
| t3social | 2.48 | .82 | .90 | -.045 | .504** | .461** | .747** | .591** | .551** | | | | | | | | | | | | |
| t1diseng | 1.61 | .62 | .86 | -.101** | .074* | .030 | -.014 | .215** | .161** | .100* | | | | | | | | | | | |
| t2diseng | 1.60 | .61 | .85 | -.143** | .049 | .107** | -.042 | .130** | .250** | .038 | .595** | | | | | | | | | | |
| t3diseng | 1.61 | .66 | .87 | -.138** | .022 | .025 | .113** | .115** | .148** | .220** | .556** | .550** | | | | | | | | | |
| t1strain | 1.89 | 1.27 | .95 | -.083** | .143** | .131** | .126** | .213** | .213** | .179** | .519** | .490** | .425** | | | | | | | | |
| t2strain | 1.97 | 1.33 | .96 | -.143** | .120** | .147** | .126** | .184** | .236** | .197** | .457** | .558** | .469** | .723** | | | | | | | |
| t3strain | 2.00 | 1.38 | .97 | -.125** | .130** | .098* | .177** | .206** | .207** | .237** | .458** | .470** | .535** | .721** | .729** | | | | | | |
| t1tstr | 13.69 | 4.71 | .94 | -.052 | .173** | .169** | .160** | .254** | .273** | .208** | .555** | .481** | .455** | .650** | .591** | .597** | | | | | |
| t2tstr | 13.96 | 4.86 | .94 | -.103** | .179** | .211** | .116** | .249** | .283** | .204** | .485** | .535** | .461** | .588** | .676** | .588** | .767** | | | | |
| t3tstr | 14.01 | 4.99 | .95 | -.063 | .125** | .153** | .197** | .199** | .229** | .271** | .471** | .489** | .545** | .554** | .572** | .634** | .745** | .759** | | | |
| t1dep | 3.68 | 1.05 | .90 | -.094** | .438** | .382** | .398** | .372** | .323** | .340** | .108** | .077* | .096* | .219** | .195** | .225** | .339** | .315** | .308** | | |
| t2dep | 3.69 | 1.10 | .92 | -.090** | .402** | .436** | .357** | .345** | .365** | .314** | .076* | .060 | .063 | .175** | .185** | .215** | .264** | .335** | .274** | .852** | |
| t3dep | 3.65 | 1.10 | .92 | -.081* | .416** | .393** | .412** | .376** | .343** | .382** | .069 | .064 | .068 | .173** | .190** | .218** | .252** | .279** | .339** | .825** | .841** |

*Note*. Sample size = $N_{t1}$ = 1,215, $N_{t2}$ = 840, $N_{t3}$ = 631, active = active coping, social = social instrumental support, diseng = behavioral disengagement, strain = technology-related strain, tstr = techno-stressors, dep = IT dependency, t1-t3 = measurement point 1-3, **Correlation is significant at the .01 level (2-tailed), *Correlation is significant at the .05 level (2-tailed).

**S2 Table. Results from MLM with techno-stressors and active coping as mediators.**

**Within Level**

**Outcome: active coping**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| tstr | .098 | .031 | .001 | .048 | .149 | .024 | .010 |
| dep | .095 | .030 | .002 | .045 | .145 | | |

**Outcome: technology-related strain**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| tstr | .292 | .034 | .000 | .237 | .347 | .092 | .000 |
| active | .076 | .026 | .004 | .033 | .119 | | |
| dep | -.026 | .035 | .452 | -.083 | .031 | | |

**Between Level**

**Outcome: techno-stressors**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.037 | .031 | .224 | -.088 | .013 | .125 | .000 |
| dep | .348 | .029 | .000 | .300 | .396 | | |

**Outcome: active coping**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.030 | .029 | .286 | -.077 | .017 | .339 | .000 |
| tstr | .020 | .036 | .568 | -.038 | .079 | | |
| dep | .571 | .035 | .000 | .514 | .628 | | |

**Outcome: technology-related strain**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.068 | .024 | .004 | -.106 | -.029 | .618 | .000 |
| tstr | .790 | .021 | .000 | .756 | .824 | | |
| active | .012 | .036 | .742 | -.048 | .072 | | |
| dep | -.043 | .033 | .200 | -.097 | .012 | | |

**Total, Direct and Indirect Effects**

**age to strain**

| | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.122 | .033 | .000 | -.176 | -.068 |
| total indirect | -.054 | .025 | .029 | -.095 | -.013 |
| via tstr | -.029 | .024 | .224 | -.069 | .010 |
| via active | .000 | .001 | .753 | -.002 | .002 |
| via tstr and active | .000 | .000 | .748 | .000 | .000 |
| direct effect | -.068 | .024 | .004 | -.106 | -.029 |

*Note*. Model was fit using Mplus 7.1. *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/ UL = 95% lower-level and upper-level confidence interval, active = active coping, tstr = techno-stressors

**S3 Table. Results from MLM with techno-stressors and social coping as mediators.**

**Within Level**

**Outcome: social coping**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| tstr | .116 | .032 | .000 | .064 | .168 | .021 | .016 |
| dep | .061 | .028 | .029 | .015 | .107 | | |

**Outcome: technology-related strain**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| tstr | .290 | .034 | .000 | .235 | .290 | .093 | .000 |
| social | .081 | .027 | .002 | .037 | .124 | | |
| dep | -.024 | .035 | .488 | -.081 | .033 | | |

**Between Level**

**Outcome: techno-stressors**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.038 | .031 | .221 | -.088 | .013 | .125 | .000 |
| dep | .348 | .029 | .000 | .300 | .397 | | |

**Outcome: social coping**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.087 | .030 | .003 | -.137 | -.038 | .284 | .000 |
| tstr | .168 | .035 | .000 | .110 | .225 | | |
| dep | .433 | .035 | .000 | .376 | .490 | | |

**Outcome: technology-related strain**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.065 | .024 | .006 | -.104 | -.026 | .618 | .000 |
| tstr | .785 | .021 | .000 | .750 | .820 | | |
| social | .030 | .033 | .372 | -.025 | .084 | | |
| dep | -.049 | .029 | .097 | -.097 | .000 | | |

**Total, Direct and Indirect Effects**

**age to strain**

| | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.122 | .033 | .000 | -.176 | -.068 |
| total indirect | -.057 | .025 | .022 | -.097 | .016 |
| via tstr | -.029 | .024 | .222 | -.069 | .010 |
| via social | -.003 | .003 | .394 | -.008 | .002 |
| via tstr and social | .000 | .000 | .447 | -.001 | .000 |
| direct | -.065 | .024 | .006 | -.104 | -.026 |

*Note.* Model was fit using Mplus 7.1. *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/ UL = 95% lower-level and upper-level confidence interval, social = social instrumental support, tstr = techno-stressors

**S4 Table. Results from MLM with techno-stressors and behavioral disengagement as mediators.**

**Within Level**

**Outcome: behavioral disengagement**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| tstr | .225 | .035 | .000 | .167 | .282 | .047 | .001 |
| dep | -.053 | .030 | .072 | -.102 | -.005 | | |

**Outcome: technology-related strain**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| tstr | .266 | .032 | .000 | .213 | .319 | .107 | .000 |
| diseng | .147 | .032 | .000 | .094 | .200 | | |
| dep | -.012 | .034 | .717 | -.067 | .043 | | |

**Between Level**

**Outcome: techno-stressors**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.037 | .031 | .226 | -.087 | .013 | .126 | .000 |
| dep | .349 | .029 | .000 | .301 | .398 | | |

**Outcome: behavioral disengagement**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.114 | .026 | .000 | -.067 | .007 | .569 | .000 |
| tstr | .782 | .025 | .000 | .741 | .823 | | |
| dep | -.168 | .030 | .000 | -.217 | -.119 | | |

**Outcome: technology-related strain**

| | Estimate | SE | *p* | LL | UL | $R^2$ | *p* |
|---|---|---|---|---|---|---|---|
| age | -.030 | .022 | .175 | -.067 | .007 | .665 | .000 |
| tstr | .531 | .050 | .000 | .449 | .613 | | |
| diseng | .331 | .055 | .000 | .241 | .421 | | |
| dep | .021 | .024 | .380 | -.018 | .021 | | |

**Total, Direct and Indirect Effects**

**age to strain**

| | Estimate | SE | *p* | LL | UL |
|---|---|---|---|---|---|
| total | -.122 | .033 | .000 | -.176 | -.068 |
| total indirect | -.091 | .027 | .001 | -.136 | -.046 |
| via tstr | -.020 | .016 | .226 | -.046 | .007 |
| via diseng | -.038 | .011 | .000 | -.055 | -.020 |
| via tstr and diseng | -.010 | .008 | .245 | -.023 | .004 |
| direct | -.030 | .022 | .175 | -.067 | .007 |

*Note.* Model was fit using Mplus 7.1. *N* = 1,216, SE = standard error, *p* = two-tailed *p*-value, LL/ UL = 95% lower-level and upper-level confidence interval, diseng = behavioral disengagement, tstr = techno-stressors

**S5 Table. Spiral Effects: results from two serial mediation models.**

| **Model 1 (age → $t_1$ strain → $t_2$ diseng → $t_3$ strain)** | | | |
|---|---|---|---|
| | **$t_1$ strain** | **$t_2$ diseng** | **$t_3$ strain** |
| | $R^2$ = .05*** | $R^2$ = .25*** | $R^2$ = .54*** |
| | β [95 % CI] | β [95 % CI] | β [95 % CI] |
| age | -.01 [-.02; .00] | -.01 [-.01; .00] | -.01 [-.02; .00] |
| $t_1$ dep (control) | .26 [.16; .35] | -.01 [-.06; .03] | .10 [-.02; .00] |
| $t_1$ strain (M1) | | .22 [.19; .25] | .65 [.03; .17] |
| $t_2$ diseng (M2) | | | .34 [.19; .48] |
| **direct effect** | | | |
| age → strain $t_3$ | | | -.01 [-.01; -.00] |
| **indirect effects** | | | |
| age → $t_1$ strain → $t_3$ strain | | | -.01 [-.01; .00] |
| age → $t_1$ strain → $t_2$ diseng → $t_3$ strain | | | -.00 [-.00; .00] |
| age → $t_2$ diseng → $t_3$ strain | | | -.00 [-.01; .00] |

| **Model 2 (age → $t_1$ diseng → $t_2$ strain → $t_3$ diseng)** | | | |
|---|---|---|---|
| | **$t_1$ diseng** | **$t_2$ strain** | **$t_3$ diseng** |
| | $R^2$ = .02*** | $R^2$ = .22*** | $R^2$ = .37*** |
| | β [95 % CI] | β [95 % CI] | β [95 % CI] |
| age | -.01 [-.01; -.00] | -.01 [-.02;-.00] | -.00 [-.01; .00] |
| $t_1$ dep (control) | .06 [.01; .11] | .23 [.14; .32] | -.01 [-.05; .03] |
| $t_1$ diseng (M1) | | .82 [.67; .96] | .43 [.36; .50] |
| $t_2$ strain (M2) | | | .13 [.10; .17] |
| **direct effect** | | | |
| age → diseng $t_3$ | | | -.00 [-.01; -.00] |
| **indirect effects** | | | |
| age → $t_1$ disng → $t_3$ diseng | | | -.00 [-.01; .-00] |
| age → $t_1$ diseng → $t_2$ strain → $t_3$ diseng | | | -.00 [-.00; -.00] |
| age → $t_2$ strain → $t_3$ diseng | | | -.00 [-.00; -.00] |

*Note*. *SE* = standard error, * = *p*-value < .05, ** = *p*-value < .01, *** = *p*-value < .001, dep = IT-dependency, diseng = behavioral disengagement, strain = technology-related strain, CI = 95% confidence intervals based on bias corrected bootstrap analyses with 1,000 repetitions.

# Chapter 4

## GENERAL DISCUSSION

## Summary and Discussion of Main Findings

The overall goal of this dissertation was to better understand how age relates to the technology adoption process. The technology adoption process was divided into two parts: For one, the role of age was analyzed in relation to determinants of technology use (study 1) and for another, age was analyzed in relation to technostress and coping behaviors (study 2). Concordantly, this chapter will begin with a brief summary and discussion of each study. Moreover, additional limitations and research opportunities, not yet discussed in the study manuscript, will be introduced. After that, theoretical and practical implications deriving from the combined results of both studies will be discussed. The directions for future research comprise a study outline that is designed as a follow-up of study 2. Finally, the chapter ends with general conclusions drawn from the present dissertation.

### Study 1: Age and Technology Acceptance

**Summary.** Study 1 provided meta-analytically aggregated results on how, why and when chronological age is related to technology acceptance. By synthesizing available evidence of 144 independent studies, this meta-analysis synchronizes the inconsistent the inconsistent body of the available literature.

The results of study 1 showed aggregated negative bivariate relationships between age and determinants of technology use (PEOU, PU, and ITU). These findings initially supported previous studies, which suggested negative associations between age and technology acceptance (e.g., (Chong, Chan, & Ooi, 2012; Escobar-Rodriguez & Bartual-Sopena, 2013). However, a meta-analytic path model on the full TAM revealed that when indirect effects were taken into account, age was neither directly related to PU nor to ITU. The negative age-PU relationship was fully mediated through PEOU, and the negative age-ITU relationship was fully mediated sequentially through PEOU and PU. Thus, there was no evidence for the proposed theoretical explanations of age differences in PU and ITU. Rather, lower technology adoption rates in older adults seem to be mainly driven through increased efforts to handle technologies (PEOU), but neither through a lack of perceived benefit (PU), nor through social influences (ITU). Hence, age-related physical and cognitive decline (e.g., (Salthouse, 2004, 2014) makes it more difficult for older adults to develop technology-related skills and learn complex operation procedures in relation to technology use. These findings provide further evidence against the stereotype of the technophobe older adult (Finkelstein, King, & Voyles, 2015; Neves & Amaro, 2012), and explain why older adults use less technologies, despite recognizing the benefits of technology use similarly to younger adults.

Moderated mediation analyses on the full TAM revealed that age effects were moderated by type of technology. Specifically, the just described pattern of age-TAM relationships was only evident for technologies not addressing the needs of older adults, such as growth and knowledge acquisition technologies. Consequently, for technologies less relevant to older adults, the age-ITU relationship was influenced stronger through PEOU than through PU. Yet, no age effects were evident for technologies addressing social and emotional needs. Thus, how age is related to technology acceptance seems to be driven through the field of application or the purpose of the technology. Specifically, age seems to be unrelated to the TAM variables if the technology already fulfills a specific need of older adults. Consequently, the type of technology seems to be a boundary condition for negative associations between age and technology acceptance.

Furthermore, bivariate age-TAM relationships were not moderated by year of data collection. The associations between age and attitudes towards technology (PU, PEOU) were stable over time despite societal changes, such as being exposed to a multitude of technologies in current times. Hence, findings seem to be genuine age-effects connected to age-related changes in needs, and physical and cognitive decline.

Finally, bivariate age-TAM relationships were not moderated by usage context. Thus, age effects did not differ in mandatory and voluntary settings. Therefore, similar underlying processes may explain age effects in occupational (where technology use is not optional) and private settings.

**Limitations and research opportunities.** In addition to the limitations already discussed in the study manuscript, I would like to introduce one additional limitation and associated research opportunity of study 1.

The concept of *digital natives* refers to individuals who grew up surrounded by digital media (Prensky, 2001, 2009). Members of the digital natives, born after 1980 (Palfrey & Gasser, 2008), are accustomed to the vast amounts of today's digital information, parallel information processing and multitasking. On the contrary, technologies have been introduced to *digital immigrants* at a later point in their lives. Because of that, digital immigrants need to learn the "digital language" much like a foreign language and differ from digital natives in their attitudes as well as their behaviors towards technology (Prensky, 2001, 2009). Even though the concept of digital generations has been critiqued (Guo, Dobson, & Petrina, 2008; Helsper Ellen & Eynon, 2013; VanSlyke, 2003), much previous research on technology acceptance relied on this concept (Friemel, 2016; Gu, Zhu, & Guo, 2013; Shafiq Obeidat & Young, 2017; Teo & Zhou, 2017; Vodanovich, Sundaram, & Myers, 2010; Q.E. Wang, Myers, & Sundaram, 2013). Based on this reasoning, including the digital generation as a moderator could help to further differentiate knowledge on the relationship between age and technology acceptance. However, studies included in this meta-analysis comprised all kinds of samples (e.g. working population, general population sample) with the result that reported age-effects are based on individuals of both generations. As a conclusion, the results of study 1 may reflect how age effects change over time (e.g. as a results of being more and more exposed to technologies in general), but the used approach is unfit to examine differences between generations (e.g. digital natives vs. digital immigrants).

**Study 2: Age and Technostress**

**Summary.** Study 2 provided results based on a longitudinal study on how coping strategies mediate the age-technostress process in occupational settings. In the following paragraphs three main findings will be highlighted and discussed.

Results showed that age was negatively related to the level of ICT-related strain. These associations were not due to job-related differences in technology use, since ICT-dependency in work fulfillment was controlled for. The findings devaluate common age stereotypes suggesting that older workers are change resistant, unwilling to adopt new technologies, and less suited for ICT-related jobs (Finkelstein et al., 2015; Kornadt & Rothermund, 2015; McDonough, 2016; Neves & Amaro, 2012; Posthuma & Campion, 2008). Moreover, age was not associated with the level of overall techno-stressors. Hence older and younger individuals experience a similar amount of taxing situations connected to ICT use in their work (e.g. techno-overload, techno-complexity, techno-uncertainty, techno-insecurity, techno-invasion). Interestingly, these results contradict previous findings, which suggested both higher levels of techno-stressors in older adults (Fuglseth & Sørebø, 2014; Shu, Tu, & Wang, 2011; Tu, Wang, & Shu, 2005; K. Wang, Shu, & Tu, 2008), as well as lower levels of techno-stressors in older adults (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2011). According to the latter aging is associated with increased organization-specific experience, greater implicit knowledge about potentially stressful situations, higher resilience, and increased coping competency (Baltes, Staudinger, & Lindenberger, 1999; Blanchard-Fields, 2007; Diehl & Hay, 2010; Scheibe & Carstensen, 2010). Older adults might profit from these age-related resource gains when encountering potentially stressful work situations, such as techno-stressors. However, aging is also connected to physical decline (Salthouse, 1996, 2004, 2014) that makes handling complex technologies as well as the processing and the coordination of information necessary for technology use more effortful for older adults (Morris & Venkatesh, 2000; Morris, Venkatesh,

& Ackerman, 2005). Situations related to the handling of ICTs (techno-overload, techno-complexity, and techno-uncertainty) might therefore more often be perceived as taxing by older as compared to younger adults. On the contrary, situations connected to the overall work situation (techno-insecurity, and techno-invasion) might be less associated with age due to the aforementioned age-related resource gains. These counteractive processes call for a more differentiated view on how and when age relates to the perception of different dimensions of techno-stressors.

In study 2 the negative relationship between age and ICT-related strain was mediated through behavioral disengagement, but not through other coping strategies. In other words, older workers profited from using less dysfunctional coping, such as less avoidant behaviors, when confronted with techno-stressors. Hence, the reason why older workers reported less technology-related strain was not because they used more functional coping, but because they used less dysfunctional coping.

Higher age was associated with lower levels of coping in all measured coping strategies (active coping, seeking instrumental social support, and behavioral disengagement). Consequently, there was no empirical evidence for the theoretical assumptions made on the positive association between age and problem-focused coping (active coping, seeking instrumental social support). One possible reason might be that general theories of aging are not sufficiently situation-specific to be applied to specialized constructs, such as techno-stressors. An alternative theoretical explanation for the negative association between age and problem-focused coping might be that older workers are more efficient in coping and, as a result, show lower levels of coping than younger adults. This might explain why age is associated with a decreased level of technology-related strain, while at the same time being associated with lower levels in coping behavior. This line of reasoning would imply a qualitative difference in coping between younger and older workers, rather than a quantitative difference. Higher coping efficiency in older workers might be due to greater organization-specific knowledge and the accompanying possibility to turn to the "right" places in order to deal with a taxing situation. Furthermore, any type of coping over a longer period of time was associated with higher ICT-related strain. As a conclusion, problem-focused coping seems to be rather dysfunctional when confronted with techno-stressors over a longer period of time. Yet, the effectiveness of coping strategies in short-term settings should be addressed in future studies.

**Limitations and research opportunities.** In addition to the limitations already discussed, I would like to introduce and discuss three additional limitations of study 2 in greater detail.

First, I would like to point out one limitation related to the longitudinal design of study 2. In study 2 individuals were asked to recollect their encounters with techno-stressors and associated coping behaviors over a longer period of time (four months). This retrospective measurement approach might be spurious, due to personality-related differences in recollecting emotional events. For example, research suggests that a retrospective approach to measuring stressful events and associated behaviors might be biased by individuals' dispositional traits (Bolger, 1990; Peterson, 1980). Self-reports might further be affected by generalized self-perceptions, social norms and stereotypical attitudes (Baltes et al., 1999; Rauschenbach & Hertel, 2011; Scheibe & Carstensen, 2010). Furthermore, the so called positivity effect is more pronounced in older adults. For example, in experimental settings older adults recall more positive than negative information (Charles, Mather, & Carstensen, 2003; Scheibe & Carstensen, 2010). The means of measurement (e.g. retrospective assessment) might therefore result in inaccurate results. Moreover, in study 2 coping was measured by asking participants about what they usually did when they encountered ICT-related stressful situations (since the last measurement point). Hence, coping was not bound to a specific ICT-situation. However, previous studies suggested that the evaluation of the effectiveness of coping, measured as the effectiveness in reducing emotional outcomes, might vary depending on its assessment as situation-specific vs. dispositional (Knoll, Rieckmann, & Schwarzer, 2005). In order to shed more light on the effectiveness of situation-specific coping strategies in relation to techno-stressors, future studies should use shorter time intervals between the stressful event, coping and assessment. This could reduce recollection biases and clearly distinguish the assessment of dispositional from situational coping.

Second, age effects on the technostress process might not be linear. Midlife is characterized by a unique position—shifting from growth and knowledge orientation towards social and emotional goals (Carstensen, 2006). Over the life-span, individuals encounter normative life-events such as entering the labor market, marriage, and parenthood (Wrzus, Hänel, Wagner, & Neyer, 2013). However, midlife is especially characterized by changes, challenges, and increased responsibilities in work and private life (Heckhausen, Wrosch, & Schulz, 2010; Schulz & Heckhausen, 1996). Consistent with that, the frequency of daily stressors turned out to be highest for the age group 25-39 (Almeida & Horn, 2004). This corroborates the assumption that the general increase of work and life demands and accompanying stressors during midlife affect middle-aged workers general resilience and resources (Rauschenbach & Hertel, 2011). Potentially demanding situations could therefore be more often perceived as taxing by middle-aged workers compared to younger and older workers.

It is indeed plausible that some dimensions of techno-stressors are not associated with age in a linear fashion. For example, the dimension techno-invasion might be perceived as less severe by younger workers, who have a higher orientation towards growth and knowledge acquisition, hence, towards work and career. Furthermore, older workers might perceive situations related to invasion of private life as less severe, due to their experience in handling stressful work situations. On the contrary, middle-aged workers might have reduced resources to cope with stressors, and do not yet possess the experience of older workers. Therefore, they might have a higher tendency to feel disturbed by blurring boundaries between work and home, such as being constantly available for work. Initial evidence for a non-linear relationship between age and stress is provided in previous research, showing an inverted U-shaped relationship between age and emotional reactivity to work-related stressors (Rauschenbach & Hertel, 2011).There is also some evidence that middle-aged workers were the most stressed age group when confronted with task-related changes (Seppala, 2001). Finally, results from a systematic review suggested that the association between ICT use and perceived strain was non-existent in a younger age group (under 35 years), positive in a middle-aged group (between 35 and 45 years), and negative in an older age group (over 45 years; Berg-Beckhoff, Nielsen, & Ladekjær Larsen, 2017). Hence, evaluating non-linear effects of age on the technostress process might enhance the understanding of how age is related to technostress in the work context.

Third, although the results of study 2 demonstrate the extent to which workers of different ages engage in specific coping behaviors, it remains unclear for which reasons they do so. Coping behavior may be seen as a consequence of secondary appraisal. Secondary appraisal refers to evaluating available resources, such as individual's coping competencies, and social support (Lazarus & Folkman, 1987). However, more research is needed to understand how coping behaviors become activated. As argued in study 2, individual characteristics (e.g. conscientiousness, agreeableness, and neuroticism) may influence secondary appraisal processes, and consequently the choice for or against a coping strategy. Thus, personality traits may play a major role in the decision to either engage in adaptive or maladaptive coping. Future studies should aim at identifying variables that increase the likelihood of engaging in adaptive coping strategies in response to techno-stressors. Previous calls have even pointed out that "there is scope for developing and clarifying concepts such as IT related resilience or mindfulness, and examining their influence on the extent to which individuals undertake specific coping responses." (Tarafdar, Cooper, & Stich, 2017; p.16).

**Theoretical and Practical Implications**

Derived from the combined results of study1 and study 2, this dissertation makes a number of important theoretical and practical contributions:

The meta-analysis on age and technology acceptance (study 1) provides the first quantitative synthesis of the relationships between age and components of technology acceptance as well as several important moderators of these relationships. Thereby, this study makes an important contribution to the understanding of how and under what conditions age is related to technology adoption. Results of study 1 emphasize the importance of considering the TAM as a whole when investigating age effects. Whereas the isolated view on bivariate relationships supported common stereotypes about older adults, taking indirect effects into account resulted in a finer grained picture about the underlying processes. Findings of this study provide clear and informative insight into the controversy surrounding the association between age and TAM variables. Furthermore, insights into important moderating conditions of the relationship between age and technology acceptance inform researchers and practitioners about boundary conditions of the age-technology acceptance relationship.

To date no study exists that addressed the relationship of age-contingent coping behavior in association with technostress in a longitudinal setting. Study 2 provides insights into how workers across the age-span cope with a digitalized work environment. Specifically, results show that lower technology-related strain in older workers is explained by less behavioral disengagement, whereas problem-focused coping strategies did not mediate this relationship.

Organizations may use the findings to implement age-sensitive measures in health-care management, human resources development, and organizational culture. For example, results of study 1 suggested that differences in technology adoption intentions between younger and older adults are mainly due to decreased levels of PEOU. This highlights the importance for an age-sensitive workplace design, which considers age-related physical and cognitive capabilities. Considering age-related physical declines might positively influence the intention to use work technologies in older workers.

Additionally, human-resources management may impart knowledge about sources of technostress and effective ways to deal with situations related to technostress. This could be done by creating an infrastructure that enhances information exchange about techno-stressors and ways to cope with it among employees. Older workers could share their insights about ways to handle technostress creating situations (possibly only techno-invasion, techno-uncertainty, techno-insecurity) with younger managers based on their increased organization-specific knowledge (Tarafdar et al., 2011). Likewise, younger workers could share their insights based on their technology-specific knowledge with older workers. Such an approach might have the additional advantage to decrease negative age-stereotypes about older adults.

Organizational structures and processes may be adapted in order to avoid situations related to technostress and increase technology-related coping competency as part of workplace health promotion. Organizations should seek to create work environments that encourage and support productive, constructive, and flexible ICT use. This could be achieved by increasing workers' ICT skills through training, promoting awareness of ICT functions such as filtering e-mails, offering programs that promote work-life balance, offering the possibility to switch off ICT devices, offering flexible work schedule, as well as providing low-key IT-support.

Furthermore, results of study 1 imply that older adults have more negative attitudes towards technologies in case the technology is not perceived as beneficial or addressing their individual needs. As a conclusion, older workers might be willing to adopt new technologies, as long as they see the benefit of doing so. Therefore, organizations should seek to explain and emphasize the benefits of newly introduced technologies.

**Directions for Future Research**

In addition to the already discussed research opportunities in the first sections of this chapter, I will present a research outline for a laboratory study. The proposed research outline serves as valuable complement to the already conducted studies in answering the overall research question. Specifically, the study is designed to address limitations of study 2 by using an experimental setting. This section will start with a brief reiteration of shortcomings of study 2, followed by the presentation of the study design, theory and hypotheses for the laboratory study.

Study 2 addressed adverse outcomes of technology use in a longitudinal setting relying on retrospective reports on techno-stressors and associated coping behavior. This approach might be biased due to individual differences in recalling emotional events. Moreover, this approach allows no conclusion on the effectiveness of situation-specific coping in relation to techno-stressors. Results of study 2 showed that chronological age was not associated with the level of overall techno-stressors. However, experimental designs could help to understand the relationship between age and dimensions of techno-stressors in a more differentiated way. Furthermore, laboratory experiments offer the possibility to systematically vary dimensions of techno-stressors (especially situations related to handling ICTs) and coping strategies. Another advantage of experimental settings is that the comparison between experimental groups and control groups in standardized settings allow causal interpretation of effects, whereas the regression based data analyses and path models as conducted in study 1 and study 2 do not allow for such an interpretation. Finally, the use of objective stress measures may provide information beyond self-reported strain levels. So far, most studies concerning technostress used quantitative data collected through survey methods (Tarafdar et al., 2017). Yet, one study that used both physiological stress measures as well as self-reported data to measure technostress showed that results of the measures did not correspond (Galluch, Grover, & Thatcher, 2015). Moreover, very few studies addressed specific dimensions of techno-stressors relying on physiological stress measures (Nomura, 2006; Riedl, Kindermann, Auinger, & Javor, 2012; Tams, 2017; Tams, Craig, & Murphy, 2011).

**Laboratory study**

The aim of this study is to address adverse consequences of technology use and the effectiveness of different coping strategies immediately after experiencing techno-stressors in a laboratory setting. The theoretical foundation of this study is based on study 2, but the proposed research design will allow to address aforementioned limitations.

**Study design.** The study consists of 2 age groups (young adults, older adults) dealing with 3 dimensions of techno-stressors (techno-overload, techno-complexity, and techno-uncertainty) using 4 coping strategies (active coping, seeking social support, behavioral disengagement, free choice of coping). This would result in a 2 x 3 x 4 between-subjects design.

So far studies concerning human-computer interaction used a variety of objective stress measures, such as heart rate variability, blood pressure, muscle tonus, adrenaline, and cortisol (for an overview see (Riedl, 2013). The advantages of using salivary cortisol sampling are that the method is non-invasive, taking multiple samples is easy and relatively stress free (Takai et al., 2004). Therefore, I propose to use salivary cortisol as a biomarker of psychological stress. The following dependent variables should be measured:

1) self-reported strain (survey based)
2) physiological stress (e.g., salivary cortisol)
3) task performance

Self-reported and objective stress levels will be measured at three time points (cf. Figure 1). The stress level before exposure to the techno-stressor will function as the baseline stress level (T0). Stress levels after exposure to the techno-stressor (T1) and after coping (T2) will be compared to the individual baseline.

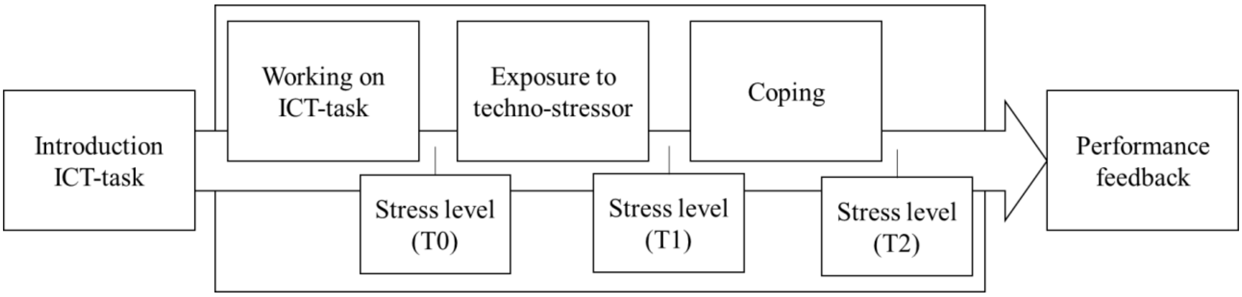


*Figure 4.1.* Experimental Procedure of Laboratory Study

In the following theoretical assumptions, proposed hypotheses, and the experimental manipulation procedure will be described in chronology to the experimental procedure.

**Introduction to ICT-task.** Techno-stressors refer to situations in which the work-flow and concentration on the task on hand is hindered or challenged. Therefore, simple, yet cognitive demanding tasks assure cognitive involvement of participants, while at the same time not inducing stress themselves. Previous studies used ICT-tasks such as online memory games (Tams, 2017; Tams et al., 2011), online shopping tasks (Riedl et al., 2012), simple computer-based calculation tasks (Nomura, Tanaka, & Nagashima, 2005), or a short period of computer-based work operations (Nomura, 2006). In the present experiment participants will be asked to build a simple webpage for a new company project that is going to be launched soon. Participants are provided with content (e.g., headings, texts, and pictures) that should be incorporated in the webpage in accordance with a prepared template for the webpage. The utilized software provides an intuitive click-and-point user interface. This ICT-task has the advantage of being more comparable to actual work tasks than context free tasks, such as memory games. In order to ensure sufficient motivation for successful task completion, participants will be informed about receiving feedback on their performance.

**Exposure to Techno-stressors.** Techno-stressors directly related to the handling of ICTs are techno-overload, techno-complexity, and techno-uncertainty. In the following sections I will briefly introduce each techno-stress construct, theorize how age might be associated with it, and present three hypotheses based on the provided theoretical assumptions. At the end of the section I will describe how each techno-stressor may be experimentally induced.

Techno-overload describes situations that require to work more and work faster due to information overload, interruptions, and multitasking (Ragu-Nathan et al., 2008). Information overload refers to situations in which users are forced to process more information than they can efficiently handle (Tarafdar et al., 2011). ICT-related interruptions refer to situations in which sustained mental attention is made difficult due to incoming emails or instant messages (Tarafdar et al., 2011). Previous studies showed that interruptions of the workflow lead to increased levels of strain and frustration by breaking individuals' concentration (Galluch et al., 2015; Tams et al., 2011). Moreover, aging is associated with lower levels of inhibitory control, such as lower selective attention (Tams, 2017). Hence, older adults might be more vulnerable to situations that require multitasking. When faced with techno-overload older adults might perceive higher levels of self-reported strain, as well as higher levels of physiological arousal compared to younger adults.

Techno-complexity describes situations that require time and effort in order to learn and understand new software applications (Tarafdar et al., 2011). As described in study 1 aging is associated with cognitive decline, such as a decrease in working memory, memory capacity, and processing abilities (Salthouse, 1996, 2004, 2014). Research showed that older adults take more time adopting new technologies and perceive technologies as less easy to use than younger adults (Morris & Venkatesh, 2000; Morris et al., 2005). Hence, learning how to operate a new or complicated system might be associated with higher levels of self-reported and objective stress for older adults than for younger adults.

Techno-uncertainty describes situations of continuing ICT upgrades and changes, which make previous skills obsolete (Tarafdar et al., 2011). Research showed that experimentally induced uncertainty is perceived as stressful and is associated with increased levels of physiological arousal, such as increased blood pressure (Greco & Roger, 2003). Adapting to constant changes might require greater effort from older adults compared to younger adults due to age-related physical decline. Therefore, situations of techno-uncertainty might be associated with higher levels of self-reported and objective stress for older adults than for younger adults. The hypotheses are:

*H1: Exposure to techno-overload, techno-complexity, and techno-uncertainty will increase the stress level of all participants (T0-T1).*

*H2: The increase in stress level after exposure to techno-stressors (T0-T1) will be greater for older adults as compared to younger adults.*

*H3: These effects will be evident based on both self-reported strain levels as well as objective stress levels.*

Techno-overload could be experimentally induced by letting participants pursue an ICT-task i) while processing simultaneous streams of real-time information ii) while being confronted with incoming emails, instant messages and other informative notifications. Techno-complexity could be experimentally induced by asking participants to learn a new software or program. Techno-complexity could be achieved by variations of the complexity of the software, for instance building a simple webpage using an intuitive point-and-click-based interface vs. using a programming language. Techno-uncertainty could be experimentally induced by letting participants pursue a series of work operations within the same software but each time slight variations of the software control mechanisms are required.

**Coping: Effectiveness.** As an extension of study 2 (long-term setting), three technology-related coping strategies (active coping, seeking instrumental social support, and behavioral disengagement) will be tested on their effectiveness to reduce emotional outcomes in a short-term setting (cf. Figure 4.2). In the following sections I will briefly revisit results of study 2, present three hypotheses on the effectiveness of technology-related coping in short-term settings, and describe how coping behavior may be evaluated in an experimental setting.

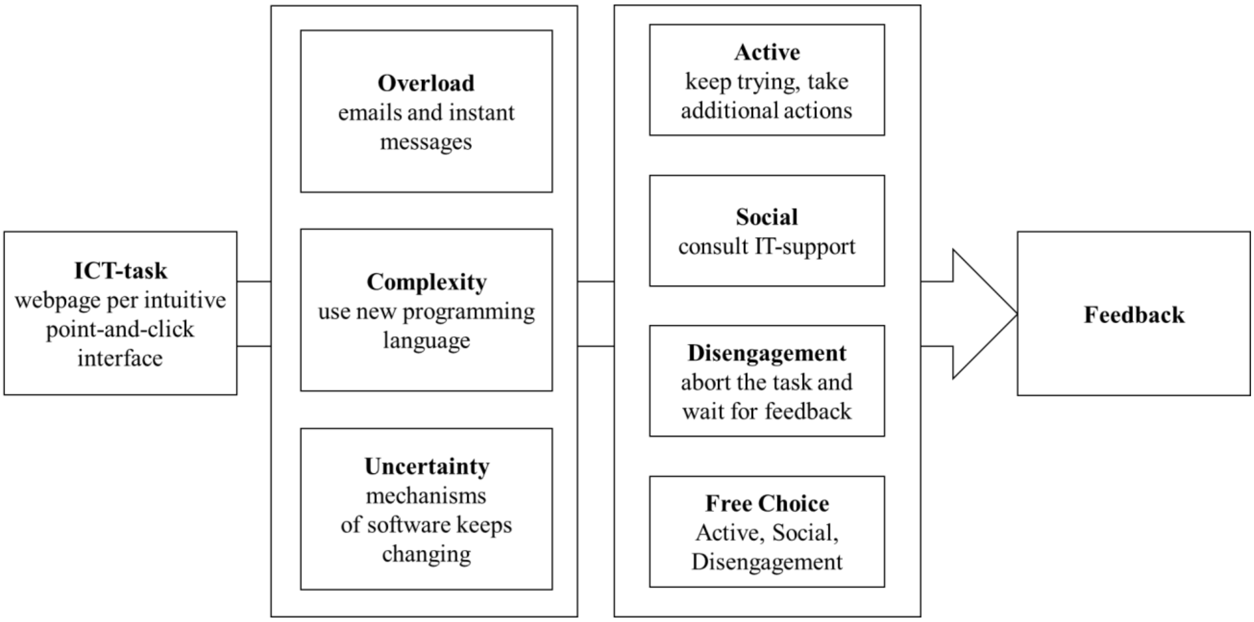


*Figure 4.2* Combination of Techno-stressors and Coping Strategies in Laboratory Study

Results of study 2 showed that higher levels of problem-focused coping (active coping, and seeking instrumental social support) were associated with increased technology-related strain over a longer period of time (in this case 4 months), just as higher levels of behavioral disengagement were associated with increased technology-related strain. The aim of the present study is to reevaluate the effectiveness of situation-specific coping with momentary techno-stressors that can actively be addressed and diminished. The effectiveness of coping will be measured as the decrease of individuals' strain levels over time (T1-T2) as well as compared between groups (using different coping strategies). Based on common classification of coping strategies (Carver, Scheier, & Weintraub, 1989), the hypothesis are:

*H3: Problem-focused coping will decrease strain levels from T1 to T2.*

*H4: Behavioral disengagement will increase strain levels from T1 to T2.*

*H5: Groups (based on type of coping strategy) significantly differ in the effectiveness of reducing strain.*

Coping behavior can be experimentally induced instructing participants to engage in one specific coping strategy when encountering problems related to the ICT-task (cf. *Experimental manipulation of techno-stressors*). Specifically, participants are instructed to either (a) keep trying to solve the problem and take additional actions, such as consulting a user-manual (problem focused – active coping), or (b) consult IT-support providing standardized assistance (problem-focused – seeking instrumental social support), or (c) abort the task in case of disturbances and wait for performance feedback (avoidant – behavioral disengagement). It is important to ensure that both problem-focused strategies provide the potential to change the stressful situation. For example, when encountering questions in relation to the function of the ICT (techno-complexity), the relevant information needs to be given in the manual or by the IT-support. Nevertheless, unsuccessful coping attempts need to be recorded and further explored in the analyses.

**Coping: Free choice of coping.** Contradicting the hypotheses of study 2, the results showed that chronological age was associated with lower levels of problem-focused coping. However, it is unclear if these patterns of coping strategy choices apply only to coping with techno-stressors over a longer period of time, or if similar patterns of coping strategy choices will be made in short-term settings. Two alternative theoretical explanations for negative association between age and problem-focused coping have been proposed: First, older adults decrease their coping efforts in order to conserve their energy over a longer period of time (Aldwin & Levenson, 2001). This would actually indicate a functional way of dealing with ongoing stressors. Second, age-related gains in general coping competency (Aldwin & Levenson, 2001; Baltes et al., 1999; Blanchard-Fields, 2007; Carstensen, 2006; Scheibe & Carstensen, 2010) do not apply to highly specific stressors, such as techno-stressors. If the findings of study 2 are due to the longitudinal setting, age-related coping patterns should differ in short-term settings (when faced with a single techno-stressor). However, if age-effects on coping depend on other variables, such as task-specific knowledge (regardless of the duration of the stressor), similar age-related coping patterns should be found in both settings (short-term vs. longitudinal). Moreover, based on the theorizing in study 2, older adults should be less likely to engage in behavioral disengagement due to higher levels of conscientiousness and agreeableness (Specht, Egloff, & Schmukle, 2011), assuming that both age-groups (younger and older) are equally motivated to perform well in the ICT-task.

Besides, research showed that having the sheer availability of coping options decreases strain levels regardless of the intensity of the actual techno-stressor (Galluch et al., 2015). As a consequence, being presented with coping options, as in this experimental condition, should be associated with lower strain levels at T1 and T2 compared to the condition of having no free choice of coping. The Hypotheses are:

*H5: Older adults will engage less in behavioral disengagement than younger adults.*

*H6: Older adults will engage less in seeking social instrumental support than younger adults.*

*H7: Older and younger adults do not differ in the level of active coping.*

*H8: Strain levels (T1, T2) in the free choice of coping condition will be lower than in the forced coping condition regardless of the type of techno-stressor.*

The choice of coping can be experimentally induced by offering a variety of coping strategies as part of the introduction to the experimental setting. Specifically, the participants will be informed of available coping options in case of encountering problems related to the ICT-task (cf. *Experimental manipulation of techno-stressors*). The available coping options are (a) consulting a manual (problem focused – active coping), or (b) consulting IT-support (problem-focused – seeking instrumental social support), or (c) aborting the task and waiting for performance feedback (avoidant – behavioral disengagement). A disadvantage of this methodological approach is that participants are prompted to make a coping strategy choice, which is unnatural. However, asking participants for the reason of their coping strategy choices could give valuable insights to age-contingent coping choices.

Summing up, the proposed research outline addresses age-related differences concerning the technostress process by comparing 2 age groups (young adults, older adults) dealing with 3 dimensions of techno-stressors (techno-overload, techno-complexity, and techno-uncertainty) using 4 coping strategies (active coping, seeking social support, behavioral disengagement, free choice of coping).

**General Conclusion**

The results of this dissertation provide a base for a more comprehensive understanding of older adults as users and consumers of technology, especially in the work context. A differentiated view on technostress and coping mechanisms is pivotal against the backdrop of demographic change and higher participation rates of older adults within the workforce. Profound knowledge on the interaction of age, technology acceptance, technostress, and technology-related coping mechanisms are of considerable importance as this knowledge enables politicians, technology developers, employers, health care providers, and other stakeholders to better address the needs of an aging, technology-reliant society. However, the overlapping processes of age, technology-acceptance, and technostress have not been evaluated in this great detail as they are in the present dissertation.

This dissertation provides an integration of 144 independent studies. Thus, bringing much needed closure to inconsistent findings on age and technology acceptance. Furthermore, very little knowledge exists on the effectiveness of individuals' technology-related coping behaviors. A longitudinal field study with 1,216 employees over a time period of 8 months contributed to identifying effective coping strategies in association with techno-stressors. Knowledge on how chronological age relates to stress that is created through ICT use in occupational settings may be beneficial to develop organizational interventions to help workers of all ages to cope more effectively with technology-related strain. In addition, this dissertation informs researchers about the next steps to shed light on the technostress research field, by providing an outline on how to systematically investigate the relationship between age and technostress in future studies.

As an overall conclusion, this dissertation revealed that negative stereotypes about older adults and technology are not warranted for several reasons: First, chronological age was not associated with negative attitudes regarding the usefulness of technologies. In fact, the negative association between chronological age and intention to use a technology was mainly driven through increased difficulties in handling technologies, which older adults encounter due to physical decline. Second, chronological age was associated with lower levels of technology-related strain and unrelated to techno-stressors in occupational settings. Therefore, from a well-being point of view, occupations depending on ICT use might actually be more suitable for older adults than younger adults.

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## List of Figures

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# APPENDIX (in German)

## Zusammenfassung

Die vorliegende Dissertation beschäftigt sich mit zwei wichtigen Themen der heutigen Zeit: dem demografischen Wandel und der zunehmenden Verbreitung von Technologien im Alltag. Im Zuge des demografischen Wandels steigt die Teilhabe älterer Arbeitnehmer in Unternehmen. Diese positive Entwicklung ist auch mit neuen Herausforderungen verbunden. Das Ziel der vorliegenden Arbeit war es, Alter als zentrale Variable im Zusammenhang mit verschiedenen Aspekten von Techniknutzung zu untersuchen. Dazu wurden zwei unabhängige Studien durchgeführt: Studie 1 beschäftigte sich mit dem Zusammenhang von Alter und der Akzeptanz von Technologien. Studie 2 beschäftigte sich mit dem Zusammenhang von Alter und Stressreaktionen durch Techniknutzung.

In der ersten Studie wurde eine Metaanalyse durchgeführt, die die heterogenen Studienergebnisse zum Thema Alter und Technologieakzeptanz statistisch aggregierte. In die Analysen sind Ergebnisse aus 144 unabhängigen Studien eingegangen. Es ergaben sich negative bivariate Zusammenhänge zwischen Alter und Variablen der Technologieakzeptanz (wahrgenommene Einfachheit der Nutzung, wahrgenommene Nützlichkeit, und Nutzungsintention). Aus metaanalytischen Pfadmodellen ging jedoch hervor, dass die Zusammenhänge zwischen Alter und wahrgenommener Nützlichkeit sowie zwischen Alter und der Nutzungsintention nicht mehr signifikant waren, wenn alle Variablen in einem Modell gleichzeitig berücksichtigt wurden. In diesem Fall wurde der Zusammenhang zwischen Alter und wahrgenommener Nützlichkeit vollständig durch die wahrgenommene Einfachheit der Nutzung erklärt, und der Pfad von Alter zu Nutzungsintention wurde sequentiell durch die wahrgenommene Einfachheit der Nutzung und die wahrgenommene Nützlichkeit mediiert. Eine moderierte Mediationsanalyse ergab, dass Alterseffekte auf Technologieakzeptanz durch die Art der Technologie moderiert wurden. Darüber hinaus

konnte keine Veränderung dieser Effekte über die Zeit oder über verschiedene Situationen hinweg (freiwillige vs. verpflichtende Nutzung) festgestellt werden.

Die zweite Studie beschäftigte sich mit der Rolle von Alter bei der Entstehung und der Bewältigung von technologiebezogenem Stress am Arbeitsplatz. Dazu wurden in einer Onlinebefragung Daten von 1216 Arbeitnehmern über einen Zeitraum von 8 Monaten zu drei Zeitpunkten erfasst. Die Ergebnisse ergaben einen negativen Zusammenhang zwischen Alter und technologiebezogenem Stresserleben. Dieser Zusammenhang konnte durch die Bewältigungsstrategie Verhaltensrückzug erklärt werden, die von älteren Arbeitnehmern weniger häufig eingesetzt wurde. Aktive Bewältigung und instrumentelle Unterstützung hingegen hatten keinen mediierenden Einfluss auf diesen Zusammenhang. Die Identifikation von effektiven Bewältigungsstrategien im Zusammenhang mit technologiebezogenem Stress ermöglicht es, den Umgang mit stressigen Situationen bei Arbeitnehmern zu verbessern und die Auswirkungen von technologiebezogenem Stress an Arbeitslätzen zu verringern.

Diese Dissertation leistet darüber hinaus einen Beitrag dazu, Vorurteile gegenüber älteren Menschen, zum Beispiel ältere Menschen seien nicht bereit und nicht geeignet mit dem technologischen Fortschritt mitzuhalten, zu widerlegen. In den durchgeführten Studien konnte weder gezeigt werden, dass sich ältere und jüngere Menschen in ihrer Einstellung zu Technologien unterscheiden, noch dass ältere Arbeitnehmer höhere Belastungsreaktionen durch die Nutzung von Technologien berichten.

# Publikationsliste

## Wissenschaftliche Artikel

Hauk, N., Hüffmeier, J. & Krumm, S. (2018). Ready to be a Silver Surfer? A Meta-analysis on the Relationship Between Chronological Age and Technology Acceptance. *Computers in Human Behavior*, 84, 304-319. https://doi.org/10.1016/j.chb.2018.01.020

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## Fragebögen

Kothgassner, O.D., Felnhofer, A., Hauk, N., Kasthofer, E., Gomm, J. & Kryspin-Exner, I. (2012). *TUI: Technology Usage Inventory Manual.* Wien: FFG.

**Erklärung**

Hiermit versichere ich, dass ich die vorliegende Arbeit allein verfasst und keine anderen als die angegebenen Hilfsmittel verwendet habe. Diese Arbeit ist in keinem früheren Promotionsverfahren angenommen oder abgelehnt worden.

Berlin, den 26.06.2018

Nathalie Hauk