The Digital Age: Exploring Age and Technology amid the COVID-19 Pandemic

Rebecca Vineberg

A Thesis in the John Molson School of Business

Presented in Partial Fulfillment of the Requirements
for the degree of Master of Science (Option Management) at
Concordia University
Montreal, Quebec, Canada
December, 2021

CONCORDIA UNIVERSITY

School of Graduate Studies

This is to certify that the thesis prepared

By: Rebecca Vineberg

Entitled: The Digital Age: Exploring Age and Technology amid the COVID-19 Pandemic

and submitted in partial fulfillment of the requirements for the degree of

Master of Science (Management)

complies with the regulations of the University and meets the accepted standards with respect tooriginality and quality.

Signed by the final Examining Committee:

______________________________ Chair & Examiner

Dr. Ingrid Chadwick

______________________________ Examiner

Dr. Kathleen Boies

______________________________ Supervisor

Dr. Linda Dyer

Approved by ______________________________ Graduate Program Director

Dr. Linda Dyer

Thursday, December 16th , 2021 ______________________________ Dean

Dr. Anne-Marie Croteau

ABSTRACT

The Digital Age: Exploring Age and Technology amid the COVID-19 Pandemic

Rebecca Vineberg

The COVID-19 pandemic challenged organizations to accelerate and transform their technology landscape in order to support business continuity by introducing aspects such as remote work and process automation. Central to research on technology in the workplace is the concept of age, and how older workers adapt to technology compared to younger peers. The extant literature on age and technology in the workplace posits that older workers are less willing and able to adapt to and adopt technology, and tends to focus on factors such as neurological and physiological aging as well as motivational factors related to using technology. The following quantitative and qualitative research proposes a model of aging and technology in the workplace from a stereotype-threat perspective, and hypothesizes that subjective age can play a role in older workers' self-perceptions of their ability to use technology. Through time-lagged research that looked at both quantitative and qualitative measures, we found support for the role of cognitive age in predicting computer anxiety and computer self-efficacy better than chronological age. In addition, we found evidence that comparative age plays a role as well, such that workers with similarly aged colleagues tend to evaluate their experiences using technology differently than workers with younger colleagues. Overall, the research supports that social and environmental factors are salient considerations that must be understood more clearly in order to truly understand the relationship between age and technology adoption.

Keywords: Age, technology, stereotype, computer anxiety, computer self-efficacy

ACKNOWLEDGEMENTS

First, I'd like to extend endless thanks and gratitude to my supervisor, Linda Dyer – your patience, commitment, and support has been a north star for me, and I truly could not have done this without you.

To my committee members, Kathleen Boies and Ingrid Chadwick – thank you for your expertise, advice, and inspiration throughout this journey.

To my chosen families at Deloitte, CN, and Reitmans – thank you for serving as constant inspiration and orienting my research towards what matters most: enabling and empowering people to perform their very best at work.

To my mom and dad – thank you for the endless opportunities and unconditional support and encouragement you have provided me with.

To my sisters, Allysha and Emily – thank you for the (sometimes not) healthy competition and for pushing me to keep working when things got challenging.

To my partner, Aaron – thank you for being my therapist, sounding board, accountability coach, and most importantly, pillar to lean on.

To my baby, Paulie – this is for you, little man.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

The Digital Age: Exploring Age and Technology amid the COVID-19 Pandemic

PREFACE

On March 11th, 2020, the novel coronavirus (COVID-19) was declared a global pandemic by the World Health Organization (WHO) (World Health Organization, 2020). I was on vacation in New York City when the first COVID-19 case in New York was reported, on March 1st. After the confirmation of the first case, I observed sharp changes in how people interacted with others and with the world around them. The people I passed on the street seemed nervous and untrusting of everyone and everything they came in contact with. Friends hesitated when greeting one another, stepping back from the normal hugs and handshakes and instead offering stifled smiles and nods. Distance was maintained on public transit and in the airport, small coughs and sneezes caused heads to turn.

Working as a digital adoption specialist in the midst of the COVID-19 pandemic has given me a unique perspective on digital transformation and managing change. Upon my return from vacation, I was under quarantine for 14 days, where I worked remotely and monitored my temperature and symptoms diligently. I longed for in-person meetings, brainstorming sessions, and informal coffee chats. I routinely felt out of loop and learned about new developments a lot slower than my colleagues who were at the office. One thing that I noticed with remote work was that I had to change the ways I went about communicating and seeking information. I could no longer rely on learning information through the traditional channels, in in-person team meetings and through informal encounters in the office. More than ever, I had to leverage technology to share and source information, and initiate instant communication with my peers. I began to notice things about technology that I never did before. Namely, I had to start considering things like network strength, information accesses and security, and file size in order to do my job efficiently.

While trying to adapt, I patiently waited for the day I could go back to the office and interact with my colleagues. That day never came. Just one week into my two-week self-quarantine, COVID-19 was declared a global pandemic and my workplace shifted to remote work.

The impact of COVID-19 on digital transformation

Unquestionably, the onset of the coronavirus pandemic massively disrupted the world as we know it, as schools, restaurants, stores, travel, and more were forced to shut down. However, for many organizations, the COVID-19 pandemic represented a massive catalyst and acceleration for digital transformation (Evans, 2020). For example, Shedletsky (2020) has proposed that, due to the pressures put on current supply chain models and the "new normal" of consumption patterns, the manufacturing industry will experience the equivalent of five years' worth of transformation over the course of just 18 months. Manufacturing is not the only industry undergoing exponential change; as the business landscape has moved online, Stephen Ibaraki, Information Technology (IT) expert, has projected that the 5^{th} Industrial Revolution – the digital technology revolution - could occur in less than 5 years, as opposed to the initially proposed decade (2020).

The ubiquity of technology in the workplace, and the rapid pace at which technology develops and evolves, has been of growing importance in the organizational literature. Technology implementation is highly costly from a financial capital standpoint, as well as from a human resources standpoint; technology implementation interrupts the flow of business and imposes enormous pressures in the form of new systems, process, tools, expectations, and roles and responsibilities on an organization's human capital (Lippert & Davis, 2006). The COVID-19 pandemic has forced organizations of different sizes across different industries to re-examine their organizational strategies and shift their focus towards how technology can facilitate the achievement of goals (Rjeily, 2020). Central to the COVID-19 digital transformation is the need for organizations to shift towards remote work (Callinan & Wong, 2020). The remote work reality has implications from both an IT strategy standpoint and a human capital standpoint alike (Swift, 2020). Remote work has forced organizations to identify and moderate organizational silos that can act as barriers to communication and collaboration, and upskill employees to be able to use technology autonomously. Strong technology infrastructures, including new hardware, software, and network connectivity are foundational, but workforce enablement and adoption will dictate which organizations will succeed in the face of economic uncertainty (Tescher, 2020).

Technology implementation projects often fail to produce the expected ROI because of their inability to address the human barriers to technology adoption among workers (Lippert & Davis, 2006; Venkatesh & Bala, 2008). Indeed, the new business landscape has brought to light the recognition that the digital gap many organizations believed existed looks more like a deep digital chasm (Tescher, 2020). That is, many organizations are forced to examine where they stand in terms of their digital assets and literacy, and many are realizing they are lagging far behind (Tescher, 2020; Callinan & Wong, 2020). Prior to COVID-19, organizations had much more choice in the matter of when to change, and which change initiatives to prioritize (Callinan & Wong, 2020). For example, although perhaps not a priority before the coronavirus pandemic, communications technologies, like Microsoft Office 365, Zoom, and Skype, have quickly become vital for most organizations in order to enable the transition to work from home and facilitate digital customer experiences and interactions (D'mello, 2020).

Almost immediately after the onset of the pandemic, personal, social, and professional life has changed fundamentally. The move to work from home has brought with it a sharp shift in business strategy as the technology transformation roadmap is pushed to the forefront. Greater emphasis is placed on the need to improve the technology infrastructure to ensure that work from home is supported with the same level of network connectivity as in-office work. There is a need to introduce automation so that many jobs can be done remotely or with reliance on fewer individuals. It is critical to enable the digital workplace to ensure that information can be shared among colleagues and teams seamlessly as if in person.

The change management process

Classic models of organizational change management postulate that, in the face of transformation, individuals go through multiple phases throughout the change journey. Successful change implementation is characterized by integration or adoption of the desired changes (George, 2016). For example, the Kübler-Ross Change Curve is developed from a model of how individuals pass through stages of grief and holds that individuals pass through stages of shock, denial, frustration, depression, experiment, and decision, before reaching the final stage, integration of the change (Kübler-Ross, 1996). Similarly, the Change Acceptance Curve posits that the goal of organizational change efforts is to move individuals up the curve through phases of awareness, understanding, buy-in, and acceptance (George, 2016). Accordingly, organizational change strategies focus on harmonising organizational processes and structures and aligning them to the desired future state, and deploying meaningful communications and training plans in order to ensure that individuals are willing and able to work in the new environment (Rosenbaum, More, & Steane, 2018). Central to traditional change models is the notion of time. Over time, individuals pass through a series of phases before reaching a point of adoption or productivity, and change management plans offer guidance and support along the way. The pace of digital disruption brought on by the COVID-19 pandemic, however, is dramatically shortening the change adoption curve by eliminating time from the equation. Models of change management are shifting from intentional, “slow and steady” plans towards disruptive “quick and dirty” efforts. Indeed, some industry experts have compared change management in the COVID-19 era to treatment of acute medical conditions, where stabilization is the focus, as opposed finding longer term solutions (Kane, Nguyen Phillips, Copulsky, & Nanda, 2020). Many organizations are being forced to transform without having the time to assess impacts and build change plans (Hughes, 2020). To this end, the lack of time to introduce new technologies sequentially and purposefully poses a challenge to change practitioners who require planning and time to socialize changes and allow affected stakeholders to build new skills and competencies ahead of implementation.

The challenge for older workers

The COVID-19 pandemic imposes an additional set of challenges on older workers. Older workers are seen as being affected the most by the pandemic, especially relative to younger workers (Agovino, 2020; Miller 2020). The current public health narrative positions older individuals as being more at risk of experiencing negative symptoms if they contract the virus (Ayalon et al., 2020). Because of this, older workers are more likely to be laid off or furloughed from their jobs than their younger counterparts, or forced into early retirement (Agovino, 2020; Miller 2020; Nazareth, 2020).

The shift towards work from home may also be a point of contention for older workers. Research has demonstrated that older workers tend to have a higher need for affiliation at work (Rhodes, 1983) and a lower need for autonomy (Cook & Wall, 1980), and may therefore be more negatively impacted by the social isolation that the pandemic has brought on.

Additionally, older workers are thought to be less familiar and less comfortable with using both existing and new technology, including many of the work-from-home tools (Agovino, 2020).

Taken together, this suggests that older workers may experience increased work-related anxiety and stress, and technology-induced anxiety and stress, amid the coronavirus pandemic, and provides an interesting backdrop against which to conduct research. As older workers make up the largest growing population segment, and as aging is fluid and will eventually impact all workers (de Koning & Gelderblom, 2006; Borghans and Ter Weel, 2002), it is critical to look at this demographic in order to better understand the experience of older workers, particularly in light of the COVID-19 pandemic.

Research agenda

Research in the field of Organizational Behaviour (OB) and Information Systems (IS) alike has done considerable work in developing models that help explain the phenomenon of technology adoption intention and technology use. However, there is a growing need to reconcile the OB literature and the IS literature in order to develop a more robust understanding of how and why individuals make a conscious decision to accept a new technology (Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh & Bala, 2008). That is, while there exists a comprehensive body of knowledge on determinants of technology adoption and acceptance, little work has explored the role of age in explaining why some individuals feel more efficacious learning and using a new technology while others do not (Venkatesh et al., 2003).

It is of growing interest for academics and practitioners alike to deepen the understanding of technology implementation, particularly as it relates to age (Lippert & Davis, 2006; Venkatesh & Bala, 2008). Moreover, the extant body of research on age and technology adoption suggests that age is indeed a relevant variable worth further exploration, but is not well-understood (Venkatesh et al., 2003; Morris & Venkatesh, 2008; Hong, Lui, Hahn, Moon, & Kim, 2013). Much of the age and technology literature is built upon the traditional technology acceptance model (Davis, 1989; Venkatesh et al., 2003) and focuses on characteristics of the technology itself, including ease of use and usefulness. There is a need to explore more deeply the relationship between age and technology, specifically as it relates to internal characteristics such as affect, emotion, self-esteem, and confidence that may affect the decision to adopt technology.

Finally, especially in light of the COVID-19 pandemic and the accelerated digitization of the workplace, it is essential to understand the factors that enable and inhibit digital adoption. The existing literature has focused on incremental technology change where the costs of adoption are not as high as they are in a COVID environment. The new reality has identified a need to understand radical and disruptive change against a landscape characterized by uncertainty. This paper seeks to add to the literature on age and technology, and seeks to answer the question of whether older workers differ from younger workers in their self-efficacy and anxiety relative to using technology. In addition, this paper seeks to expand notions of age to include "subjective age," the age one feels, and to understand to what extent subjective age can enhance or attenuate computer anxiety and self-efficacy.

The research pursues the question: To what extent is age related to computer anxiety and computer self-efficacy? How do more subjective measures of age fit into this relationship?

The next section reviews the literature on age and technology, explains the stereotype embodiment and threat theories within which this research is rooted, and then goes on to explain the key variables of computer self-efficacy, computer anxiety, and subjective age, and how they may be related.

LITERATURE REVIEW AND THEORY DEVELOPMENT

Technology Adoption

The technology acceptance model is considered the prevailing model in explaining technology adoption as a function of technology usage intention (Davis, 1989). The technology acceptance model, which is rooted in the theory of planned behaviour, advances a model of technology adoption which holds that intention to use a new technology is preceded by perceived usefulness, or relevance to an individual's job, and perceived ease of use, or the extent to which the system requires high effort to use (Davis, 1996; Venkatesh & Davis, 2000). Since the model's inception, a number of extensions and elaborations have been proposed. For example, research that aimed to elucidate the concept of perceived ease of use has found that perceived ease of use is predicted by and therefore comprised general self-efficacy coupled with objective system usability, thus providing the first integration of characteristics that are internal to the user (Venkatesh & Davis, 1996). Across three different studies, 108 participants were given varying levels of training ranging from user documentation to hands-on training, and were then asked to complete a questionnaire that assessed a number of measures, including perceived usefulness, ease of use, prior experience, self-efficacy, and usage intention (Venkatesh & Davis, 1996). Results provide overall support for the model such that perceived ease of use is critical in determining intention to use technology, and contend that factors such as hands-on experience, self-efficacy, and system user-friendliness are necessary conditions for perceived ease of use (Venkatesh & Davis, 1996).

Further, research has focused on the precedents and antecedents of perceived usefulness and perceived ease of use by examining pre- and post-implementation characteristics, and how these may facilitate or impede ultimate utilization (Venkatesh & Bala, 2008). Further iterations of the technology acceptance model have included system characteristics such as objective usability, perceptions of external control, as well as social and individual attributes such as norms, motivation, enjoyment, anxiety, and self-efficacy (Venkatesh & Bala, 2008).

However, it is still not well-understood how different individuals and groups may experience new technology. In particular, little research has focused on the role of age in understanding individuals' reactions to and attitudes towards technology, and subsequent usage (Morris & Venkatesh, 2000). As well, further research is required on looking at cognitive and emotional factors in the decision to use technology (Venkatesh & Davis, 1996; Morris &

Venkatesh, 2000). Indeed, since change is a highly emotionally charged process, and change in the workplace can induce high levels of stress and negative affect (Kübler-Ross, 1996; Tams, 2001), it is critical to examine factors like anxiety and self-efficacy on their own, and not enmeshed with characteristics of the technology itself. Finally, much of the extant literature has observed technology change in a voluntary context where the individual is able to exercise choice and the cost of non-adoption is relatively low (Venkatesh, Morris, Davis, & Davis, 2003). However, there may be key differences in examining factors related to mandatory technology change where costs of non-adoption are much higher (Venkatesh, Morris, Davis, & Davis, 2003) The following section attempts to chronicle and integrate some key literature on age and technology, and some factors like anxiety, self-efficacy, and subjective age, that may help to better explain the complex relationship between age and technology use.

Age and Technology

The digital divide between younger and older workers has long been demonstrated in the literature (Heinz, 2013). The neurological aging perspective holds that older individuals are less able to learn and have poorer memory, shorter attention spans, and reduced psychomotor and visual acuity (Hawthorn, 2000). At the most micro level, the neurological level, it has been established that neuroplasticity tends to decline with age (Goh & Park, 2009). Neuroplasticity refers to the brain's malleability relative to processing information and forming new connections; as such, as neuroplasticity declines, the ability to learn new skills and the willingness to try new things tends to decline arithmetically (Goh & Park, 2009).

In line with traditional models of neurological aging, a large body of research on age and technology use contends that older workers are less likely to use computers at work, use computers less frequently, and generally have lower computer literacy on average than their younger colleagues (de Koning & Gelderblom, 2006; Friedberg, 2003; Borghans and Ter Weel, 2002). This can be explained largely due to the proposed cognitive decline associated with the aging process (Hawthorne, 2000).

However, the relationship between age and technology is not so cut-and-dry. For example, de Koning and Gelderblom (2006) surveyed 538 workers across the printing and the wholesale trade industries, both highly technology-enabled sectors. The survey measured technology use, performance, job and company characteristics, as well as individual characteristics like age and gender. Overall, the results indicate that older workers are less skilled at using technology, tend to use it less, and tend to use less complicated applications compared to younger colleagues (de Koning & Gelderblom, 2006). In addition, results indicate that technology use can hamper performance in older workers (de Koning & Gelderblom, 2006). That is, older workers whose organizations and jobs promoted technology use tended to exhibit poorer work performance compared to older workers whose roles did not rely heavily on technology (de Koning & Gelderblom, 2006). Nevertheless, in contrast to the traditional neurological aging perspective, the authors draw on human capital theory to suggest that older workers exhibit lower motivation to learn as a function of simply not seeing the need to develop their technical skills as they will be exiting the labour market sooner than their younger counterparts (de Koning & Gelderblom, 2006). The findings, while they confirm traditional beliefs about aging and technology, offer a distinct perspective on technology that highlights older workers unwillingness to adopt technology as a function of lack of motivation, rather than lack of ability.

Similarly, Friedberg (2003) examines computer use by cohort, and retirement intention. Survey and demographic results indicate an inverse relationship between technology adoption and proximity to retirement, such that as age increases, technology usage decreases (Friedberg, 2003). Further, this trend is not shown in older workers who plan to delay retirement (Friedberg, 2003). These results support the notion that employees who are older and closer to retirement simply do not see learning about new workplace technology as a worthy investment.

Further research has found that, while the digital divide between younger and older workers may never truly be eliminated, individual differences can bridge the divide. For example, one study aims to elucidate the technology acceptance model (Davis, 1989) by incorporating age as an important variable (Morris & Venkatesh, 2000). The longitudinal study looks at attitudes towards technology, subjective norms surrounding technology, and perceived behavioural control, as well as actual technology use immediately following a 2-day software training, as well as 3 and 5 months after the training and software are introduced. Results indicate that subjective norm and perceived behavioural control are stronger predictors of technology use among older workers (Morris & Venkatesh, 2000). That is, when older workers feel that others around them, including their superiors and teammates, place a large importance on technology use, and when they feel that support structures are in place to help them, they are more likely to adopt new technology. In contrast, subjective norms and perceived behavioural control are not salient predictors of technology use in younger workers (Morris & Venkatesh, 2000). Finally, the effects tend to stabilize over time, with older workers being virtually no different than younger workers after 5 months (Morris & Venkatesh, 2000). The results of this study are important as they do demonstrate the digital divide between younger and older individuals, but also show that there are underlying mechanisms at play that can perhaps complicate the relationship. Specifically, the authors challenge commonly held beliefs about older workers and their ability to learn new things. Indeed, this study suggest that older workers simply have different levers than younger colleagues that lead to technology adoption decisions (Morris & Venkatesh, 2000).

Taken together, there seem to be inconsistencies in the existing literature whereby older workers are both interested and accepting of new technology (Demiris et al., 2004), and resistant to new technology (Morrell, Mayhorn, & Bennett, 2000). These conflicting results highlight the inability of the neurological aging perspective to fully explain technology adoption in older workers, and the need to further explore the underlying mechanisms that can either enable or inhibit technology adoption. Research must therefore incorporate individual characteristics that may help account for variability, in order to develop more robust and comprehensive models of technology adoption at work. To understand how older workers come to accept or reject workplace technology, it is critical to understand self-perceptions.

Stereotype Embodiment & Threat

The relationship between age and technology is complex, multi-faceted, and has ultimately failed to address whether older workers and younger workers truly differ in their experience of new technology. The neurological aging perspective advances and propagates a myriad of unfavorable stereotypes surrounding the aging population. By and large, and in part due to stereotypes rooted in aging, older workers are seen as less productive, less able and willing to learn, less motivated, and more resistant to change than younger workers (Ng & Feldman, 2012; Kulik, Perera, & Cregan, 2016). The underlying mechanisms that muddied the literature on the digital divide between younger and older individuals may be explained by these stereotypes.

Stereotype embodiment. The stereotype embodiment perspective holds that individuals tend to unconsciously assimilate and embody pervasive stereotypes from their environments, and that these stereotypes can have subsequent impacts on performance, behaviour, and experience (Levy, 2009). Stereotypes tend to be internalized in environments where stereotypes and stereotyped group membership is more salient (Levy, 2009). That is, when the context is highly charged with negative stereotypes about a given group, like technology adoption and the aging workforce, and when group membership is particularly apparent, these stereotypes can become embodied and confirmed. Stereotypes can be seen as persistent self-fulfilling prophecies that both stem from, and have an effect on, psychological, behavioural, and physiological pathways (Levy & Leifheit-Limson, 2009; Levy, 2009). For example, in a study that looks at the pervasiveness of age stereotypes, Levy (2000) maintains that priming participants with stereotypes related to age tended to have an impact on a performance task. Participants were primed with words that carry either negative or positive stereotypes about age (for example, *senile* or *wise*, respectively), and then asked to complete a handwriting task (Levy, 2000). Results indicate that participants in the negative stereotype condition displayed poorer performance in the subsequent handwriting task than participants in the positive stereotype condition (Levy, 2000). In this sense, age can be seen as social construct, and aging as a learned behaviour (Levy, 2009).

Stereotype threat. To help explain the mechanisms that underlie stereotype embodiment theory, the stereotype threat theory (Steele & Aronson, 1995; Steele, 1997) holds that individuals react to stereotype-related signals and cues in their environment, and expend a great deal of effort trying to cognitively reconcile these stereotypes, such that they have no more mental resources left for performing at a task (Steele & Aronson, 1995; Steele, 1997; Lamont, Swift, & Abrams, 2015). Research has shown that working memory is negatively impacted in older individuals when negative stereotypes about age and memory are activated, compared to younger individuals, older individuals who are presented with positive stereotypes about age and memory, individuals in a control group, (Hess, Auman, Colcolombe, & Rahhal, 2003).

Stereotype threat at work. In an organizational context, older workers may be acutely aware of workplace stereotypes about them being poorer performers and may expend such a disproportionate amount of cognitive energy trying to block out these thoughts that their performance will suffer as a result. Simply put, stereotype threat assumes that individuals tend to underperform when they are preoccupied with thoughts that they may confirm a negative stereotype about their group (Lamont, Swift, & Abrams, 2015). In addition to performance, stereotype threat has been shown to impact motivation and goal-orientation (Kulik, Perera, & Cregan, 2015). Particularly, a number of stereotype threat-inducing cues, such as the age of an individual's manager and colleagues, has been shown to impact work engagement, such that older workers with younger managers and colleagues tend to show lower workplace engagement than those who have similar-aged managers and colleagues (Kulik, Perera, & Cregan, 2015). Indeed, stereotype threat has been shown to adversely impact older workers disproportionately in comparison to younger colleagues (von Hippel, Kalokerinos, Haanterä, & Zacher, 2019). In a longitudinal, diary-based study on stereotype threat and work experience, researchers found that both groups do experience stereotype threat. However, these threats have a negative impact on a number of workplace outcomes for older workers, including job satisfaction, engagement and commitment, turnover intention, and this relationship is mediated by stress and rumination (von Hippel, Kalokerinos, Haanterä, & Zacher, 2019).

Age stereotypes are particularly prevalent in organizational settings (Kulik, Perera, & Cregan, 2015). The wide array of different generations that make up the workforce, the ever-increasing retirement age, and the rapid pace of change and digitization tends to bring to light many negative age-related stereotypes that can have detrimental consequences on the experience and performance of older workers. As demonstrated by a number of key studies, these unconscious stereotypes can have large effects on a number of work-related outcomes (Roberson & Kulik, 2007; Kulik, Perera, & Cregan, 2015; von Hippel, Kalokerinos, Haanterä, & Zacher, 2019) In the short-term, these effects can lead to immediate declines in performance; in the long-term, it can lead to disengagement and amotivation (Roberson & Kulik, 2007; Kulik, Perera, & Cregan, 2015; von Hippel, Kalokerinos, Haanterä, & Zacher, 2019). The stereotype threat theory may help us to better understand the digital divide between older and younger workers. In workplace settings where age-related stereotypes are front and center, older employees may experience computer anxiety and negative affect surrounding technology as a function of their motivation to reject negative stereotypes. According to the stereotype threat theory, the activation of these persistent negative stereotypes may lead older workers to appraise situations where they are introduced to new technology as highly stressful and unenjoyable, and may subsequently confirm these stereotypes about older workers and technology.

Stereotypes undoubtedly impact individual self-perception (Steele & Aronson, 1995; Steele, 1997). The following section examines in more detail how these stereotypes manifest into thoughts, feelings, and attitudes towards technology as well as self-assessments of technology skills and abilities. Specifically, the following section reviews the notion of computer self-efficacy and computer anxiety, and the role of age and age stereotypes.

Computer Self-Efficacy and the Role of Computer Anxiety

Computer Self-Efficacy. Similar to the traditional concept of self-efficacy (Bandura, 1978), computer self-efficacy (CSE) refers to an individual's perceived master of and control over using technology (Thatcher & Perrewé, 2002). Simply, CSE refers to an individual's subjective appraisal of their ability to effectively use different computer hardware and software in different environments (Thatcher & Perrewé, 2002). The organizational literature has consistently demonstrated the importance of self-efficacy on a number of work-related outcomes (Sadri & Robertson, 1993). For example, self-efficacy is consistently linked to work performance, engagement, job satisfaction, and psychological well-being (Sadri & Roberson, 1993; Williams, Wissing, Rothmann, & Temane, 2010). Like self-efficacy, CSE has been cited as a key underpinning of motivation, performance, and satisfaction in the context of technology use, and has been cited as a significant predictor of technology adoption (Venkatesh & Davis, 1996; Thatcher & Perrewé, 2002).

Research on CSE has demonstrated a negative correlation with age, such that older individuals tend to exhibit lower levels of CSE than younger individuals (Czaja et al, 2006). In a large-scale study that looked at predictors of computer and internet use, Czaja and colleagues (2006) found support for the notion of the digital divide between generations. Specifically, CSE is an important variable in understanding the relationship between age and technology use, and older individuals tend to rate lower on CSE than younger individuals. The authors contend that this relationship is highly linked to experience using technology, such that lower levels of computer experience tend to predict lower levels of CSE, which in turn predicts lower usage and adoption (Czaja et al., 2006). To this end, the relationship between experience, CSE, and usage is a vicious cycle; inexperienced individuals who do not feel secure in their ability to use technology will ultimately not get the technology exposure that they need in order to enhance their feelings of self-efficacy. Central to this is the notion that experience tends to be positively related to CSE. One limitation of this research is that it was not looked at in an organizational context, but rather looked at general computer and internet use across a large population sample with ages ranging from 18 to 91 years (Czaja et al., 2006). However, it is important to consider how this manifests at work, where the conditions and the population may be different.

Due to the ubiquity of technology in the workplace, ranging from simple to complex hardware and software, older workers presumably have more experience using technology, and have experienced how technology has changed over the course of their careers. Despite this, older workers still show lower levels of technology adoption (Morris & Venkatesh, 2000; de Koning & Gelderblom, 2006; Friedberg, 2003; Borghans and Ter Weel, 2002). Thus, while there is undeniably a gap between older and younger individuals' perceptions of technology, I believe the fundamental mechanisms of this relationship are more complex in that experience and usage is not enough to predict confidence and self-efficacy. I believe that older workers' relationship with technology, and their self-perceptions of their ability to use technology, are heavily influenced by social and environmental factors. Specifically, in line with stereotype embodiment and stereotype threat theories (Levy, 2009; Steele & Aronson, 1995), I propose that older workers will internalize negative stereotypes perpetuated by theories of aging related to their ability, and therefore experience lower CSE than younger workers:

> ***H1:*** *Age and computer self-efficacy are negatively related, such that older workers will experience lower levels of computer self-efficacy than younger workers.*

Computer Anxiety. Computer anxiety, often referred to as "technostress" and "computer phobia" denotes an individual's sense of comfort and ease with using technology, acceptance of technology, and affective reactions to using technology (Heinssen, Glass, & Knight, 1987; Laguna & Babcock, 1997; Tu, Wang, & Shu, 2005). Computer anxiety is not seen as a personality trait, but rather an emotional state which occurs when an individual is using or thinking about using technology (Chua, Chen, & Wang, 1999). Computer anxiety is an increasingly important factor to consider when looking at the relationship between age and technology adoption (Tams, 2011), as it has been associated with lower physical and mental well-being (Bozionelos, 2001), lower rates of technology use, and poorer performance with technology use (Mahar, Henderson, & Deane, 1997).

The stress literature holds that older and younger individuals differ in terms of responses to stressful stimuli, whether technology-related or not (Neupert, Miller, & Lachman, 2006; Tams, 2011). Research on the stress response has shown that age is positively related to a physiological stress response, and subsequent performance deficits (Nuepert, Miller, & Lachman, 2006). That is, compared to younger individuals, older individuals experienced heightened adrenal responses and cortisol production in reaction to stressful stimuli, and displayed lower performance on subsequent memory, speed, and reasoning tests (Neupert, Miller, & Lachman, 2006).

The literature that examines age differences with respect to computer anxiety is limited, and extant findings are somewhat inconsistent (Tams, 2011). For example, a study that looked at the impacts of technostress on work-related outcomes found that older workers experience lower levels of computer anxiety than younger workers, and in turn show higher levels of job satisfaction and organizational commitment (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008). The authors argue that older workers naturally have more work experience than younger workers, and tend to enjoy longer tenure at their organization; this experience and high level of firm knowledge on processes and operations may act as a buffer to computer anxiety (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008). However, it is important to note that the authors looked at survey responses and it is therefore difficult to argue a causal link between technostress and work-related outcomes such as satisfaction and commitment. Indeed, it can be argued that higher levels of job satisfaction and organizational commitment tend to act as protectors against the introduction of new technology. Other research that examines computer anxiety and age indicates that workers over the age of 35 tend to experience higher levels of computer anxiety than employees under the age of 35 (Tu, Wang, & Shu, 2005). As well, higher levels of technostress are consistently linked to lower levels of computer literacy (Tu, Wang, & Shu, 2005). Finally, consistent with Ragu-Nathan and colleagues (2008), high computer anxiety is linked to job dissatisfaction, burnout, and intention to leave (Tu, Wang, & Shu, 2005).

To understand technology adoption, it is important to consider how computer anxiety and CSE interact. Indeed, Bandura's (1978) concept of self-efficacy is very much tied to emotional self-regulation and stress management. The current literature integrating computer anxiety and CSE has produced inconsistent results. For example, Simsek (2011) looked at both CSE and computer anxiety in a sample of grade-school and high-school aged students, as well as their teachers. Survey results indicate that anxiety and self-efficacy tend to co-vary. Specifically, older students and teachers tend to display higher levels of computer anxiety as well as higher levels of CSE while younger students tend to exhibit lower levels of both (Simsek, 2011).

In contrast, in examining the relationship between computer anxiety and a number of key variables, Wilfong (2006) found a significant relationship with CSE, even more so than with computer experience and use.

There has been a call to integrate more social and cognitive theories into models of computer anxiety and aging in order to further explicate why such inconsistencies are found (Tams, 2011). Consistent with Bandura's (1978) original contention about self-efficacy beliefs, coping techniques that attenuate anxiety can greatly enhance self-efficacy. Given this, and given the existing literature on both computer anxiety and CSE, and how the variables may interact, I propose that computer anxiety informs CSE. That is, in line with stereotype threat theories, older workers tend to experience higher levels of computer anxiety than younger workers; higher levels of computer anxiety act as a cue for feelings of efficacy and ability relative to technology use: As such, I propose a mediating role of computer anxiety in the relationship between age and CSE:

H2: *The relationship between age and computer self-efficacy is mediated by computer anxiety, such that computer anxiety, will undermine computer self-efficacy in older workers.*

The Role of Subjective Age

A growing body of research is beginning to consider sociocognitive dimensions of age that may be important factors in predicting feelings and emotions around technology (Barak, 1987; Abrams, Eller, & Bryant, 2003; Richard, Kochan, McMillan, & Capehart, 2002). That is, chronological age may not be the only mechanism at work. Subjective age, which denotes an individual's own interpretation of their age and is highly rooted in the self-concept, may play a significant role in explaining the complex relationship between age and thoughts surrounding technology and its use (Barak, 1987). The below section reviews two measures of subjective age, cognitive age and comparative age, and their proposed role in the relationship between age, computer anxiety, and CSE.

Cognitive Age. Cognitive age is a form of subjective age that reflects the degree to which an individual identifies with a given age role (Barak, 1997). Specifically, cognitive age measures the age that an individual looks and feels, and the extent to which their behaviours and interests are aligned with others in their age group (Barak, 1987). Age research has demonstrated that lower cognitive age is linked to a number of positive outcomes, including enhanced well-being, self-image, confidence, and innovativeness (Barak, 1980; Barak, 1987; Peters, 1971). In contrast to neurological aging theories which see age as unilateral, and are rooted in the notion that cognitive function declines as age increases, subjective age contends that age is multidimensional and embedded in the self-concept.

Because self-perceptions tend to influence attitudes, behaviours, and values, it is important to consider how this may impact feelings around new technology, and its subsequent use. For example, it has been demonstrated that seniors who perceive themselves to be younger than their chronological age also use the internet more than seniors who self-identity in line with their chronological age, or older than their chronological age (Eastman & Iyer, 2005).

Although research on technology adoption and age is limited, some authors have attempted to clarify the role of cognitive age. Hong and colleagues (2013) expand on the technology acceptance model by integrating measures of cognitive age. Specifically, the researchers posit that cognitive age moderates the relationship between technology adoption and empirically validated predecessors of technology adoption, including perceived usefulness, ease of use, enjoyment, and subjective norm (Hong et al., 2013). Notably, individuals with lower cognitive ages who look, feel, and act younger than their chronological age, tend to have different anchors related to technology use; older individuals with lower cognitive ages display similar patterns to younger individuals, in that perceived usefulness and enjoyment are significant predictors of intention to use technology (Hong et al., 2013). In contrast, older individuals whose cognitive age is equal to or greater than their chronological age tend to be more influenced by subjective norms and ease of use (Hong et al., 2013).

Taken together, these results demonstrate that chronological age is not sufficient in explaining how older individuals interact with technology. In line with stereotype embodiment and stereotype threat theories, it may be that individuals who look, feel, and act younger than they are attend to environmental stereotypes much less and therefore do not experience some of the negative effects of others who may identify more strongly. Thus, I propose that older workers who have lower cognitive ages will in turn experience lower computer anxiety and higher CSE than older workers with cognitive ages that are equal to or greater than their chronological age.

H3a: *Cognitive age and computer anxiety are directly and positively related, such that workers with lower cognitive ages will experience lower levels of anxiety related to technology use. Conversely, workers with higher cognitive ages will experience higher levels of anxiety related to technology use.*

H3b: *Cognitive age and computer self-efficacy are directly and negatively related, such that workers with lower cognitive ages will experience greater computer self-efficacy. Conversely, workers with higher cognitive ages will experience lower computer self-efficacy.*

To summarize, the following model is proposed and the rest of the paper discusses a study which aims to provide support for the above hypotheses:

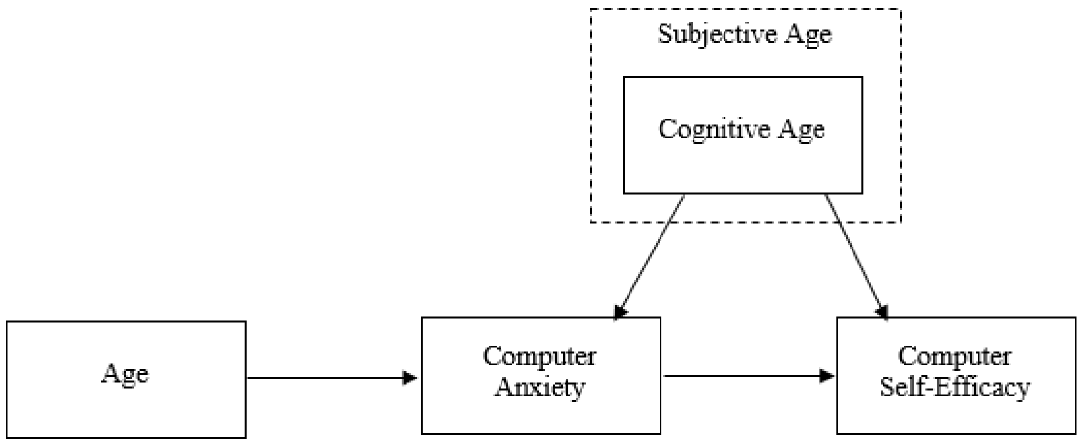

Figure 1: The proposed relationship between age, cognitive age, and computer self-efficacy, mediated by computer anxiety.

A Qualitative Component

The quantitative model is bolstered by a qualitative research component as well, which seeks to understand contextual factors, including temporal, affective, and social influences that may play a role in shaping individual experiences accepting and adopting technology. The qualitative research dives deeper into the concept of comparative age, or how participants see themselves relative to their peers and how it may play a role in activating age-related stereotypes with respect to technology.

Time. First, in line with traditional models of organizational change management, including the Kubler-Ross change curve, time is a key component in enabling individuals to navigate through complex and changing situations, as it provides them with the opportunity to learn through experience and appropriate the change. Thus, the research also seeks to understand how time plays a role in influencing affect and orientation towards changing technology.

Comparative age. Another important measure of subjective age is comparative age, which refers to an individual's age relative to other individuals around them. That is, comparative age measures whether an individual is younger or older compared to others within the same group as them. Unlike cognitive age, which is internally produced and represents self-perception, comparative age is externally driven and urges individuals to construct their age relatively.

Because aging is highly stigmatized (Heinz, 2013; Hawthorne, 2000), comparative age is a particularly important variable; in the context of age and technology at work, comparative age can call into question group membership and identification, as well as stereotype salience (Steele & Aronson, 1995; Steele, 1997; Kulik, Perera, & Cregan, 2015; Richard et al., 2002). Specifically, salience of age becomes enhanced when an individual's age makes them a minority within the group (Steele & Aronson, 1995; Steele, 1997; Richard et al., 2002). Simply put, when older workers are on teams composed primarily of individuals who are comparatively younger than them, their age – and a host of stereotypes associated with their age – may become more activated. Indeed, in line with stereotype threat theory, these types of contexts are considered to be "high threat" contexts, whereas individuals working with similarly aged peers or diverse aged peers represents a lower threat context (Kulik, Perera, & Cregan, 2015). For example, in an experiment which exposed older workers to either high threat or low threat conditions via comparison with other individuals, older individuals who were exposed to the high-threat condition tended to show higher levels of anxiety and perform more poorly on subsequent cognitive tasks relative to older individuals who were exposed to the low threat condition (Abrams, Eller, & Bryant, 2006).

Further, theories on social identity and self-categorization hold that ingroups and outgroups are psychologically formed as a result of perceived group membership on the basis of a particular characteristic (Richard et al., 2002). Ingroup biases tend to lead to outgroups being classified as deficient, which can in turn lead to negative outcomes for members of the outgroup (Richard et al., 2002). Taken together, this suggests that older workers who belong to groups where their age is highlighted by being comparatively older than other members of their groups, will think, feel, and act in ways that are in accordance with stereotypes related to their age.

The qualitative research explores the concept of comparative age more closely by looking at how workplace age composition may play a role in shaping attitudes towards age and subsequent reactions towards new technology either by activating or attenuating age-related stereotypes. Specifically, to what extent does comparative age play a role, and how?

METHOD

Procedure

The present research aims to examine the relationships between different measures of age, computer anxiety, and computer self-efficacy, and employs a time-lagged research design over the course of 1 month, that gathers both quantitative and qualitative data. Participants were sent electronic surveys via email every 7-10 days, a total of 4 times. The independent variable age was measured at Time 1. In addition, the variable comparative age and the proposed mediator computer anxiety were each measured at Time 1. The dependent variable computer self-efficacy was measured at Time 4 along with cognitive age. A number of other variables were measured over the course of the 4-week study, including organizational change, training satisfaction, and perceived voice, but are not relevant to the present study. Finally, qualitative data was gathered at each time the survey was distributed in the form of free-text answers, giving participants the opportunity to share in more detail their experience with the technology change over the course of the month. The electronic survey was developed using Qualtrics, which contained the aforementioned scales and control variables. Data was downloaded from Qualtrics and analyzed using the JASP statistical analysis software.

Participants

The participants of the present study were recruited through convenience sampling, from the networks of the researchers and through social media posts. Participation in this study was limited to people who had worked full time for five years or more and who had recently experienced technological change at work. A total of 53 participants responded to the initial invitation, and 49 participants responded to the survey at Time 1. The initial response rate was 92%. However, due to the time-lagged nature of the study, some drop-off was expected: 37 participants responded at Time 2, 33 participants at Time 3, and 32 participants at Time 4. The final sample therefore included 32 full-time employees ($N = 32$). Participants in the final sample ranged in age from 27 to 76 ($M = 49$, $SD = 12.2$). The sample was comprised of 43.7% men and 56.3% women. Organizational tenure ranged from 0.5 to 47 years ($M = 9.3$, $SD = 9.6$), and experience in current position ranged from 0.5 to 26 years ($M = 6.3$, $SD = 6.9$). Participants worked in various industries including government, manufacturing, and arts and entertainment, among others. Participation in the study was voluntary, and participants were compensated with an online retailer gift card valued at $25. All participants were provided with informed and written consent prior to participating.

Measures

Computer self-efficacy. Computer self-efficacy (CSE) was measured using an adapted version of the self-efficacy scale developed by Hartzel (2003). The questionnaire contains ten items measured on a 5-point Likert-type scale ranging from 1 ("not at all confident") to 5 ("totally confident"). The scale measures the extent to which individuals feel confident using new technology under a number of different conditions, including "if I had never used technology like it before" and "if someone else had helped me get started", among others. The scale presented an acceptable level of reliability in the current sample (α = 0.928).

Computer anxiety. Computer anxiety was measured using an adapted version of the computer anxiety scale developed by Lester, Yang, and James (2005). The questionnaire contains five items measured on a 6-point Likert-type scale ranging from 1 ("strongly disagree") to 6 ("strongly agree"). Some questions were reverse-coded. The scale includes items such as "The harder I work at learning new technologies, the more confused I get" and "I feel confident and relaxed while working with new technologies", among others. The scale was found to have an inadequate level of reliability (α = 0.623). Thus, one of the items from the scale was dropped from the analyses ("I can usually manage to solve technological problems by myself") and the reliability increased to an acceptable level (α = 0.707).

Cognitive age. Cognitive age was measured using the scale developed by Hong and colleagues (2013). The scale contained four items measuring the age that participants look ("I look as if I am in my…"), feel ("I feel as if I am in my…"), act ("I act as if I am in my…"), and what age group their interests typically fall into ("I do most things as if I am in my…"). Participants were asked to indicate age group in decades on an 8-point scale that ranged from "20s" to "90s". The scale presented a good level of reliability in the present sample (α = 0.949).

Comparative age. Comparative age was measured by asking participants to identify the general age group of other individuals with whom they work. The scale included one item ("your coworkers are mostly…"), and included the following potential answers: "young adults", “midlife adults”, “older adults”, “diverse ages”. The variable of comparative age was excluded from quantitative analyses and is explored in the qualitative portion of the research.

Chronological age. Participants were asked to report their exact chronological age in years.

Other variables

Positive affect. Positive affect was measured throughout the study using an adapted version of the positive and negative affect scale (PANAS) (Watson, Clark, & Tellegen, 1988). The scale contained 10 items which measured the extent to which participants felt a certain emotion, like “excited” or “determined”, using technology over the last week. Responses were provided on a 5-point Likert-type scale from 1 (“not at all”) to 5 (“extremely”). The scale presented acceptable levels of reliability in the present sample, across time 1 ($\alpha = 0.947$), time 2 ($\alpha = 0.953$), time 3 ($\alpha = 0.716$), and time 4 ($\alpha = 0.936$). Positive affect was not included in the overall quantitative model, but was examined along with the qualitative responses.

Control variables. A number of control variables were collected as well, including gender, organizational tenure, and position tenure. Participants were asked to select their gender from a list containing three options: “male”, “female”, and “other”. For this study, none of the survey respondents selected the “other” option and it was therefore excluded from the analyses. Participants were asked to indicate the number of years they have been working with their current organization. In addition, participants were asked to indicate the number of years they have been working in their current job role.

Qualitative data. In order to understand how individuals adapt to technological change over time, qualitative data were gathered a total of four times throughout the course of the study.

At each time, participants were asked to provide free-text comments about their individual experiences with technology over the course of the month.

Participants were also asked to provide a brief description of the type of change they were experiencing.

Ethical Considerations

The present study was reviewed and approved by the Concordia University ethics committee. The survey included a consent form at the beginning, informing participants of the research purpose, procedures, confidentiality, and conditions for participation. Additionally, participants were informed on the consent form that they could withdraw participation at any point over the course of the study without consequence. Participants were able to begin the survey only once they had agreed to the terms outlined on the consent form.

RESULTS

Preliminary Analysis

Preliminary analyses and descriptive statistics were conducted for all scales. Table 1 depicts means and standard deviations for each variable, as well as bivariate correlations among variables. As expected, age was positively and significantly correlated with some demographic variables, including organizational tenure ($r = 0.687$, $p < 0.001$) and position tenure ($r = 0.472$, $p < 0.001$). In addition, and of importance to the hypotheses, age was found to be positively and significantly correlated with computer anxiety ($r = 0.512$, $p < 0.001$), and negatively and significantly correlated with computer self-efficacy ($r = -0.381$, $p < 0.05$). Similarly, cognitive age was found to be positively and significantly correlated with computer anxiety ($r = 0.502$, $p < 0.01$), and negatively and significantly correlated with computer self-efficacy ($r = -0.533$, $p < 0.01$). As well, the preliminary analyses indicate that computer anxiety and computer self-efficacy are indeed negatively and significantly correlated (r = - 0.676, $p < 0.001$). Finally, age and cognitive age tend to be positively and significantly correlated ($r = 0.912$, $p < 0.001$).

TABLE 1: Descriptive statistics and bivariate correlations

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. Organizational tenure	7.753	8.381	-											
2. Position tenure	5.580	6.211	0.433**	-										
3. Gender	1.510	0.505	0.037	0.152	-									
4. Age	44.833	12.379	0.687***	0.472***	0.150	-								
5. Comparative age	1.169	1.176	-0.074	0.227	0.268	0.033	-							
6. Cognitive age	38.047	10.563	0.566***	0.279	-0.196	0.912***	-0.094	-						
7. Computer anxiety	2.143	0.840	0.350*	0.168	0.095	0.512***	-0.087	0.504**	-					
8. Computer self-efficacy	3.922	0.688	-0.125	-0.070	-0.102	-0.381*	-0.124	-0.533**	-0.676***	-				
9. Positive affect – T1	3.239	0.967	0.170	0.267	-0.033	0.132	0.084	-0.292	-0.044	0.291	-			
10. Positive affect – T2	3.162	1.041	0.224	0.053	-0.110	0.099	0.018	-0.198	0.187	0.157	0.767***	-		
11. Positive affect – T3	3.336	1.048	0.118	0.148	0.056	-0.051	0.070	-0.278	-0.184	0.155	0.617***	0.551***	-	
12. Positive affect – T4	3.253	0.880	0.246	0.249	-0.099	0.146	-0.163	-0.081	-0.098	0.234	0.509**	0.497**	0.608***	-

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Gender (1 = Male, 2 = Female)

Hypothesis Testing

Hypothesis 1. Hypothesis 1 posited that age negatively predicts computer self-efficacy (CSE), such that older workers tend to show lower levels of CSE than younger workers. To test this, a simple linear regression analysis was computed using the independent variable of age and the dependent variable of CSE. As predicted, age was shown to be negatively and significantly related to CSE (β = -0.381, $t(29)$ = -2.221, $p < 0.05$, R^2 = 0.145, $F(1,29)$ = 4.933, $p < 0.05$). Following this, a multiple linear regression analysis was computed to determine if the addition of control variables would affect the model. Once the control variables of organizational tenure, position tenure, and gender were added to the model, the relationship between age and CSE became non-significant (β = -0.370, $t(26)$ = -1.521, *n.s*). In addition, none of the control variables of organizational tenure (β = -0.021, $t(26)$ = -0.086, *n.s*), position tenure (β = -0.044, $t(26)$ = -0.241, *n.s*), and gender (β = -0.303, $t(26)$ = -1.763, *n.s*) were found to be significantly related to CSE (R^2 = 0.240, $F(4,26)$ = 2.047, *n.s).* Because organizational tenure and position tenure were found to be significantly correlated with age, variance inflation factor (VIF) and tolerance estimates were consulted to determine if the problem of multicollinearity was present. Indeed, both organizational tenure and position tenure demonstrated collinearity (*VIF* = 2.013, 1.149, respectively), and were therefore excluded from the model. A final multiple linear regression was computed, with the control variable of gender, the predictor of age, and the outcome of CSE. Results indicate, as predicted, a significant negative relationship between age and CSE (β = -0.399, $t(28)$ = -2.416, $p < 0.05$), and that age explains a significant proportion of variance in CSE scores (R^2 = 0.487, $F(2,28)$ = 4.359, $p < 0.05$), thus providing support for H1. Results are depicted in Table 2.

TABLE 2: H1 - The relationship between age and computer self-efficacy

Parameters	Model 1: Age and CSE		Model 2: Age and CSE with organizational tenure, position tenure, and gender as controls		Model 3: Age and CSE with gender as control	
	***β*(SE)**	***p***	***β*(SE)**	***p***	***β*(SE)**	***p***
Organizational tenure	-	-	-0.001(0.014)	0.932	-	-
Position tenure	-	-	-0.004(0.015)	0.811	-	-
Gender	-	-	-0.342(0.194)	0.090	-0.343(0.186)	0.077
Age	-0.018(0.008)	0.034*	-0.017(0.011)	0.140	-0.019(0.008)	0.022*
(intercept)	4.824(0.386)	<0.001***	5.376(0.547)	<0.001***	5.406(0.488)	<0.001***
F	4.933		2.047		4.359	
R^2	0.145		0.240		0.237	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Gender (1 = Male, 2 = Female)

Hypothesis 2. Hypothesis 2 stated that the relationship between age and CSE would be mediated by computer anxiety. To test this, a mediation analysis was conducted using the mediation analysis function in the structural equation modelling (SEM) module in JASP, with age as the predictor variable, computer anxiety as the mediating variable, and CSE as the outcome variable, as well as organizational tenure, position tenure, and gender as background confounders. Table 3 depicts the direct, indirect, and total effects. In line with H2, the indirect effects model including the mediating variable of computer anxiety was significant ($\beta = -0.333$, $z = -2.551$, $p < 0.05$). In addition, the total effects model was significant ($\beta = -0.647$, $z = -2.928$, $p < 0.01$). Thus, H2 is supported and we can conclude that the relationship between age and CSE is fully mediated by computer anxiety such that older individuals tend to experience greater computer anxiety, which in turn reduces their level of computer self-efficacy.

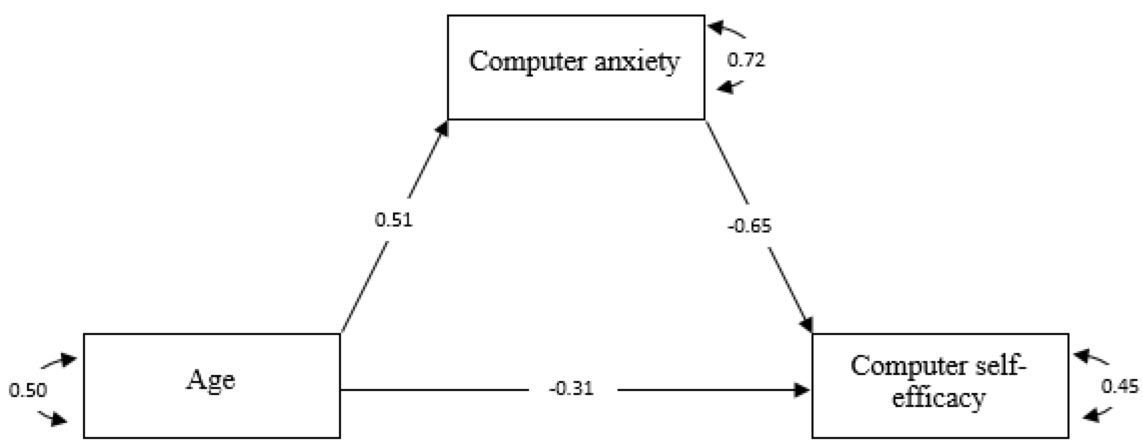

Figure 2: The path plot between age and computer self-efficacy, with the addition of the mediating variable computer anxiety.

TABLE 3: H2 - The mediating role of computer anxiety on the relationship between age and computer self-efficacy

Parameters			**95% Confidence Interval**	
	***β*(SE)**	***p***	**Lower limit**	**Upper limit**
Direct effects (age –> CSE)	-0.315(0.189)	0.095	-0.685	0.055
Indirect effects (age –> computer anxiety –> CSE)	-0.333(0.130)	0.01**	-0.588	-0.077
Total effects	-0.647(0.221)	0.003**	-1.081	-0.214

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Hypothesis 3a. Hypothesis 3a posited that cognitive age predicts computer anxiety, such that workers with lower cognitive ages (that is, look, feel, and behave younger than they are) tend to show lower levels of computer anxiety than workers with higher cognitive ages. To test this, a simple linear regression analysis was computed using the independent variable of cognitive age and the dependent variable of computer anxiety. As predicted, cognitive age was shown to be positively and significantly related to computer anxiety ($\beta = 0.501$, $t(30) = 3.195$, $p < 0.005$, $R^2 = 0.254$, $F(1,30) = 10.207$, $p < 0.01$). Following this, a multiple linear regression analysis was computed to determine if the addition of control variables would affect the model. Once the control variables of organizational tenure, position tenure, and gender were added to the model, the relationship between cognitive age and computer anxiety remained significant ($\beta = 0.502$, $t(27) = 2.439$, $p < 0.05$). In addition, none of the control variables of organizational tenure ($\beta = 0.069$, $t(27) = 0.336$, *n.s*), position tenure ($\beta = -0.089$, $t(27) = -0.501$, *n.s*), and gender ($\beta = 0.064$, $t(27) = 0.379$, *n.s*) were found to be significantly related to computer anxiety ($R^2 = 0.265$, $F(4,27) = 2.440$, *n.s)*, thus providing support for H3a. Results are depicted in Table 4.

Hypothesis 3b. Hypothesis 3b posited that cognitive age negatively predicts computer self-efficacy, such that workers with lower cognitive ages (that is, look, feel, and behave younger than they are) tend to show higher levels of CSE than workers with higher cognitive ages. To test this, a simple linear regression analysis was computed using the independent variable of cognitive age and the dependent variable of CSE. As predicted, cognitive age was shown to be negatively and significantly related to CSE ($\beta = -0.533$, $t(30) = -3.449$, $p < 0.01$, $R^2 = 0.284$, $F(1,30) = 11.895$, $p < 0.01$). Following this, a multiple linear regression analysis was computed to determine if the addition of control variables would affect the model. Once the control variables of organizational tenure, position tenure, and gender were added to the model, the relationship between cognitive age and CSE remained significant ($\beta = -0.744$, $t(27) = -3.945$, $p <$

0.001). In addition, none of the control variables of organizational tenure (β = 0.262, $t(27)$ = 1.392, *n.s*), position tenure (β = 0.061, $t(27)$ = 0.376, *n.s*), and gender (β = -0.234, $t(27)$ = -1.510, *n.s*) were found to be significantly related to CSE (R^2 = 0.383, $F(4,27)$ = 4.197, $p < 0.05$), thus providing support for H3b. Results are depicted in Table 5.

TABLE 4: H3a - The relationship between cognitive age and computer anxiety

Parameters	Model 1: Cognitive Age and Computer Anxiety		Model 2: Cognitive Age and Computer Anxiety with organizational tenure, position tenure, and gender as controls	
	***β*(SE)**	***p***	***β*(SE)**	***p***
Organizational tenure	-	-	0.069(0.018)	0.336
Position tenure	-	-	-0.089(0.022)	0.620
Gender	-	-	0.064 (0.285)	0.707
Cognitive age	0.504(0.013)	0.003**	0.502(0.017)	0.022*
(intercept)	0.741(0.500)	0.149	0.589(0.785)	0.459
F	10.207		2.440	
R^2	0.254		0.265	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Gender (1 = Male, 2 = Female)

TABLE 5: H3b - The relationship between cognitive age and computer self-efficacy

Parameters	**Model 1: Cognitive Age and CSE**		**Model 2: Cognitive Age and CSE with organizational tenure, position tenure, and gender as controls**	
	***β*(SE)**	***p***	***β*(SE)**	***p***
Organizational tenure	-	-	0.262(0.014)	0.175
Position tenure	-	-	0.061(0.016)	0.710
Gender	-	-	-0.234 (0.212)	0.142
Cognitive age	0.-533(-3.349)	0.003**	-0.744(0.012)	<0.001***
(intercept)	5.343(0.397)	<0.001***	6.053(0.583)	<0.001***
F	11.895		4.197	
R^2	0.284		0.383	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Gender (1 = Male, 2 = Female)

Qualitative analysis

In addition to the survey measures, participants were prompted to provide qualitative long-form responses on their overall experience with new technology at work. Over a four-week period, survey respondents were asked to share their issues, challenges, and experiences learning and adopting technology. For the purpose of this analysis, older participants in the workplace are characterized as those over 40 years old, in line with research conducted by Cjaza et al. (2006). The qualitative research looked at themes related to technology challenges, the role of time, and the role that subjective age plays in attitudes and behaviours towards technology.

Technology challenges. Since the COVID-19 pandemic brought on the immediate need for business to shift to work-from-home or hybrid models, consumer-grade telecommunications platforms like Zoom, Teams, FaceTime, and Skype, were the most often used and discussed by participants. Regardless of age, participants remarked that these are tools they are somewhat familiar with, or were easy to adapt to:

> "All meetings are now conducted via Zoom, Facetime or phone instead of in person. This turned out to be quite easy and I can see continuing to do this for some meetings even after we return to work."

While younger respondents under the age of 40 tended to rate their digital literacy and overall comfort with using and learning new technology as high, many older workers are adapting to new hardware and software that came with the swift shift to remote work. A 74-year old science professional recounts a fairly smooth shift to telecommunications technology:

> "With covid-19 all of my work is now via Zoom or telephone. Before only part of my work was via Zoom or the telephone. I have a basic comfort and keep learning new tips for its use."

In addition to user-friendliness and how easy some of these new technologies and tools are to learn, many respondents are enjoying functionality that they bring. Particularly in the wake of COVID-19, where many workers feel disconnected from their colleagues, the introduction of technology has enhanced the flow of information among colleagues and teams, and has improved work engagement. A 39-year old professional remarks:

> "Everyone is adapting slowly but surely making communications faster and more efficient, and less plagued by people encoutering [sic] easily solvable tech issues."

Still, despite some of the positives that came with the introduction of various digital tools and platforms, many participants faced challenges when adapting to and adopting new technology and ways of working.

Older workers tended to talk openly about their lack of familiarity with technology, "the steep learning curve", and their overall discomfort. One 76-year old participant in the Education sector raised how challenging new technology is to learn and how much more difficult it makes concentrating:

> "I am learning the new functions of the first with difficulty. The second is less difficult technologically but it does test my concentration"

Indeed, lack of focus and difficulty concentrating is a recurrent theme in older participants' responses. Unlike Millennial and Gen Z respondents who were raised in a world imbued with screens, the 40+ crowd has a tendency to see technology use as "distracting" and hard to keep focus, even those older workers who share their enjoyment of using technology. Some older respondents even feel drained by all of this newfound digital engagement – a 51-year old participant admits:

> "I am finding it exhausting to be on a screen all day and the attention needed is just too much"

It seems that learning and using new technology seems to require more attentional and cognitive resources from older workers relative to their younger, digital native peers, which in turns makes them less productive. A 44-year old wholesale and trade professional remarks:

> "Without interruption we find ourselves concentrating on work but I find I get less done and get tired more easily and faster"

Proposition 1: *Older workers differ from younger workers in terms of the attentional resources that they can devote to technology.*

Another challenge that workers face is the performance of technology. Above and beyond skill and ability using technology, many respondents reported that frequent internet, VPN, and security key issues came up, and systems tended to crash intermittently, making it more difficult to get work done. One younger survey respondent, a 29-year old retail professional notes:

> "In mid-March we were asked to work from home which I never did before so for me it was adapting my entire work-environment (new software and new equipment). So everyday [sic] I have to connect remotely from home. It does not work all the time at the first try or it even crashes in the middle of something so I have to close everything and reconnect."

Technology challenges over time. Technology-related challenges were observed regardless of age, particularly in the first week as organizations were quickly bolstering their IT infrastructure to be able to support remote working. Over the course of the research, older workers continuously raised these types of technology challenges, and expressed more frustration and confusion than their younger peers, suggesting that they may be less comfortable self-supporting to resolve technology issues. A 59-year old worker in the Education industry recounts:

> "During the last week the remote system was so bad the system would stop every 4 minutes (I timed it!) It was that way for 4 days. The 4th day I decided to go to the office for the day in order to have the tools to accomplish pressing work."

Many older workers raised issues of lagging Wi-Fi and slower internet. One 62-year old worker remarked how a similar-aged member of her team does not have internet, so she spends an inordinate amount of time transferring files back and forth via USB key. Another respondent remarked that his workplace suggested he upgrade his internet to a faster one in order to be able to connect to the VPN; he will not, as he does not "feel that should be [his] responsibility." Indeed, many older participants express frustration in their organization's failure to provide adequate technology accesses and hardware that facilitates work like faster internet, robust VPNs that can support higher volumes, and larger second monitors, as well as accompanying support resources, including training, reference material, and access to IT helpdesk support. A 54-year old respondent remarks:

> “The workplace expects us to use zoom, and we use it happily, but there was absolutely no help or support or encouragement from the workplace to use zoom. We figured it out. We are a high-functioning unit so that wasn't a problem, but I would recommend that for other sections at my workplace, or other workplace - a handout all about zoom, with instructions, should have been created and disseminated to workers at the beginning of the pandemic, if workers were expected to use it.”

Finally, by the fourth week of the study, participants were commenting less on the technology itself that they use; instead, many participants across age groups expressed feeling a blurring of the line between their work and personal life, leaving them isolated, overworked, and overwhelmed. Indeed, across the board, participants felt that they did not have adequate workspaces in their homes, and they felt that the introduction of new work-from-home technology made them permanently reachable and therefore working much longer hours than usual. One 36-year old professional laments:

> “Trying to juggle work and a [sic] almost 3 year old. The other issues what my limited resources. I had no printer or scanner or photocopier and I never realized just how much I relied on them. I also did not have a quiet workspace. It was extremely disorganized and I had to work at my

> kitchen island which made getting anything done difficult. I felt out of touch with my coworkers and frustrated on a daily basis."

The following section looks more deeply at the role of comparative age in determining technology-related attitudes and behaviours.

Age-related stereotypes. Age and age-related stereotypes emerged as key themes over the course of the four-week study. Some younger survey participants who are themselves quite comfortable with technology raise concepts such as generational gaps or diverse working groups with varying degrees of tech-savviness. Similarly, even some older workers explain their own or their peers' resistance to new technology to be a function of their age, tagging themselves as "old school" or not able to stay ahead of the technology curve. This section explores another key facet of subjective age – comparative age, which refers to an individual's age relative to other around them – and attempts to understand whether age-related stereotypes are exacerbated or attenuated by working with younger or similarly aged peers.

Of the 49 participants surveyed, six of them are older workers who work with younger colleagues. Many older study participants who work primarily with younger colleagues – that is, in high stereotype-threat environments - assert that they are actually fairly comfortable with the new technology they have needed to learn in order to shift to working from home. However, many make mention of their general lack of awareness when it comes to technology. A 41-year old non-profit worker shares that, although technology helped support a large webinar, it "was a struggle to learn". In addition, a 62-year old museum worker reports that, although she is comfortable with the technology she uses to perform her job, that she did not know what VPN was, "which shows [her] level of expertise with technology". Additionally, this participant explains one of her employees' ("an older person like [her]") reluctance to adopt technology by installing Zoom, within the context of their age and not some other factors. Even more, she shares her growing concern about having an aging parent in the age of COVID-19 who is growing increasingly more isolated as a function of her inability to learn technology:

> "She is not able to learn new technology that would reduce her isolation. Could someone not come up with a fool-proof elderly-friendly way to set-up video-conferencing? Even starting on Zoom requires some basic understanding of technological language that is beyond my mom."

Taken together, this suggests that, although this participant is herself quite savvy with technology, she see technology acceptance and adoption as a function of age – something that older people just are not that good at.

Another 63-year old participant who characterizes himself as comfortable with new technology states his dislike for the new digital ways of working:

> "I miss the human contact like a good brain storming. I know we can do it by phone or FaceTime. If it's the new way of communication, I don't like it! I'm from the old school."

It seems that age-related stereotypes become particularly salient with these participants, not when it comes to actual technology savviness or comfort, but with how they perceive and explain their own and others' reactions to technology. Indeed, taken together, it seems that these participants are more likely to rationalize theirs or others' lack of willingness to adopt technology, or lack of skills as a function of age.

Proposition 2: *Older workers who work with younger colleagues tend to experience more age-related stereotypes, and think about technology in terms of their own age.*

In contrast, I looked at five older participants who work with diverse age groups, that is, where coworkers would be of various ages. Here, stereotypes seem to become diluted, and I found that these participants tend to show less preoccupation with age than those who are in high stereotype-threat environments. These workers report the same type of experiences - some of them are "comfortable with this type of technology" while others are learning "with difficulty". The main difference with this group of participants is the lack of mention of age in any of the responses; none of these participants seem preoccupied with their own age or others' age as a potential reason for adopting or resisting technology. In this group, age-related stereotypes related to technology appear to be tempered by working with age-diverse peers.

> ***Proposition 3:*** *Work groups comprised of diverse workers tend to experience less age stereotypes regarding technology use.*

The results from the qualitative study point to the role of age-related stereotypes in determining attitudes and behaviours towards technology. Age, it seems, plays less of a role in overall comfort, ability, and willingness to accept and adopt new technology. Age seems to become increasingly relevant in highly threatening contexts that emphasize age (like being the only older worker in a group of mostly younger colleagues); in these instances, age becomes an explaining factor in why technology has not, or will not, be adopted.

Positive affect. Finally, I looked at positive affect across both older and younger workers, through qualitative and quantitative measures. Positive affect was measured along a 5-point rating scale. Despite differences in overall experiences with technology, there did not seem to be any age or time differences in the overall state affect. When asked to rate how they felt using technology, similar ratings on positive affect were observed across older respondents ($M^{T1} = 3.3$,

$M^{T2} = 3.3$, $M^{T3} = 3.4$, $M^{T4} = 3.4$) and younger respondents ($M^{T1} = 3.3$, $M^{T2} = 2.9$, $M^{T3} = 3.3$, $M^{T4} = 3.1$) over time. These results indicate that overall, irrespective of age, participants were relatively happy and that happiness was stable across the duration of the study.

> ***Proposition 4:*** *There is little link between computer anxiety, computer self-efficacy and positive affect. Across ages, positive affect remains stable over time.*

DISCUSSION

Older and younger workers do tend to have fundamentally different reactions and experiences with regards to technology, and these reactions and experiences seem to be closely related to their perception of their own age. The present research examines age and technology change from a stereotype threat perspective, and attempts to understand how situational and relational cues can influence technology adoption decisions. The study looks at critical pre-cursors to technology adoption – computer anxiety and computer self-efficacy – in addition to multiple dimensions of age, including chronological, cognitive, and comparative age. Specifically, the study hypothesizes that older workers will exhibit lower levels of computer self-efficacy than younger workers. Moreover, this relationship is mediated by computer anxiety, such that older workers tend to experience higher levels of computer-related anxiety which in turn leads to lower levels of computer self-efficacy. Finally, the research proposes that cognitive age can mitigate the effect of chronological age on computer anxiety and computer self-efficacy such that workers with lower cognitive ages will experience lower levels of anxiety and higher levels of self-efficacy when it comes to technology. In addition to the quantitative model, the research examines participants' qualitative responses regarding technology in order to develop a more comprehensive theory surrounding technology, aging, and stereotypes.

The first hypothesis proposes a direct and negative relationship between chronological age and computer self-efficacy, such that older workers will experience lower levels of computer self-efficacy. In line with our expectations and with previous research on age and technology (Czaja et al, 2006), age significantly predicts computer self-efficacy, even when variables like gender are controlled.

Similarly, the second hypothesis proposes that the relationship between age and computer self-efficacy is mediated by computer anxiety, such that older workers experience greater levels of anxiety related to technology, which in turn undermines feelings of computer self-efficacy. In line with our expectations, the indirect effects model and total effects model were significant ($p < 0.05$, $p < 0.01$). This is to be expected, as anxiety shows up in the literature as an impediment to self-efficacy (Heinssen, Glass, & Knight, 1987; Laguna & Babcock, 1997; Tu, Wang, & Shu, 2005). Indeed, anxiety can serve as a sort of cue that a threat is present. In this case, the findings from the present study suggest that, for older workers, computer anxiety serves as cognitive cue linked to using technology – a potentially threatening situation – which can diminish feelings of self-efficacy related to technology use.

The research examines elements of subjective age as well. The third hypothesis proposes that cognitive age, or the extent to which individuals look, feel, think, and behave in line with a certain age group, is positively related to both computer anxiety and computer self-efficacy, such that individuals with lower cognitive ages will, independent of chronological age, will experience lower levels of anxiety related to technology, and higher levels of self-efficacy. Indeed, in line with expectations, cognitive age is directly and positively related to computer anxiety and directly and negatively related to computer self-efficacy. Further, computer self-efficacy is better predicted by cognitive age ($R^2 = 0.383$) than chronological age ($R^2 = 0.237$).

These findings challenge the neurological aging perspective which holds that older workers are less adaptive as a function of age, and instead supports stereotype-threat theories that posit that more situational, subjective factors may determine the relationship that older workers have with technology.

Additional support for the stereotype-threat perspective on age and technology comes from the qualitative research. Overall, in line with the prevalent research on age and technology (de Koning & Gelderblom, 2006; Friedberg, 2003; Borghans and Ter Weel, 2002), older workers tended to rate their digital literacy as lower than their younger peers, and overall tended to express more feelings of difficulty adapting to new technology. More than that, the research reveals that highly threatening situations, as when age becomes more salient, tend to impact reactions to and experiences with technology. Indeed, older workers who work with younger peers tend to isolate themselves from their colleagues and seem to understand their relationship to technology as a function of their age. Age-related stereotypes become activated not when it comes to actual technology savviness, willingness, or ability, but with how they perceive and explain their own and others' reactions to technology. It seems that in these threatening environments where age is salient, older workers are more prone to activate and confirm stereotypes related to age and technology use.

Theoretical Implications

The findings of this study contribute to the literature on age and technology by incorporating dimensions of subjective age, and how age-related stereotypes can exacerbate or attenuate reactions to technology. The existing literature on age and technology takes a neurological aging or motivational lens through which to examine age; research on age and technology has seemed to overlook the role of cognitive and comparative age, and has instead focused primarily on differences in ability to learn new technology between older and younger individuals (Czaja et al, 2006) and on differences in motivating factors between older and younger individuals (Morris & Venkatesh, 2000; Venkatesh & Davis, 1996; Thatcher & Perrewé, 2002). The present study shifts our understanding of age as a fixed, singular construct into a multi-dimensional and situationally-relevant variable. In addition, the current research is unique in that it takes place in the wake of a critical time period – the COVID-19 pandemic where technology change was not only radical and forced, but occurred with a number of additional considerations as well, including work stoppages, health concerns, and isolation.

With the reality of today's technology landscape, including the ubiquity of workplace technology as well as the rapid pace at which technology changes, organizations must understand how their human capital experience fast and frequent technology transformations. The next section explores practical implications for organizations to help accelerate technology adoption and acceptance.

Practical Implications

The findings of this study help to address some of the very real challenges that organizations face, with the rapid pace at which technology changes, and the increasingly age-diverse workforce. First, understanding reactions to technology change can have significant implications on change management and technology adoption interventions when organizations are looking to modernize their digital landscape. For example, the findings can inspire organizations to be more mindful when selecting technology champions, advocates, or subject matter experts who will help drive change within the organization. By selecting older workers to fulfil these types of roles, organizations will be empowering older workers to have a voice in how technology should be rolled out, to gain hands on experience learning new tools and processes, and to signal to other older workers that similar individuals are on board with the initiative. Since older workers tend to be sensitive to age-related stereotypes, having age-similar models positioned as technology champions and subject matter experts may enhance their own computer self-efficacy. In addition, having these models also provides older workers with a "safe" space to go for questions, concerns, and support.

This type of research also magnifies the need for Diversity & Inclusion (D&I) training efforts to include generational diversity. If organizations have training programs and interventions which attempt to reduce age-related biases and increase awareness on how stereotypes shape attitudes and behaviours, the negative effects of age-related stereotypes may potentially be attenuated. Indeed, calling attention to automatic thoughts and perceptions can help disrupt this form of heuristics-based thinking that expects older workers to be inflexible and tech-illiterate, and can help enhance self-perceptions and others' perceptions of older workers' abilities and willingness to adopt new technology.

Strengths, Limitations, and Future Research Directions

Significant results from the research must be interpreted with care. Due to the time-lagged nature of the study, the sample size was smaller than desired and the sampling population may not be representative of the total workforce. In addition, the drop-out rate of participants between the first and last survey was 35%. A larger sample size may be useful in future research to derive more representative effects and insights.

There was little consistency across the various tools that participants discussed. While many of the technologies and tools are consumer-grade telecommunications tools, which tend to be easier and more user-friendly, some participants were facing more complex work process tools including ERPs, new databases, and new operating systems that impact the ways in which work gets completed. Because the technology ranged in terms complexity, results may be somewhat obscured as not all participants were working with the same building blocks. In addition, participants came from a variety of organizations that may have different practices when it comes to rolling out technology, and differences in computer anxiety and computer self-efficacy may be a function of the participants' workplace effectiveness is managing technology change. Future research may want to home in and focus on a technology implementation in a given organization to ensure that the technology and tools, as well as the effectiveness of the technology implementation are equivalent.

In addition, since chronological age and cognitive age are highly correlated, it would be interesting for future research to investigate a cross-section of the population and look at particular individuals who have discrepant chronological and cognitive ages (that is, older folks who feel younger and vice versa) in comparison to participants with congruent chronological and cognitive ages.

Finally, while the COVID-19 pandemic served as an inspiration and catalyst for the research, it may serve as a limitation as well; the pandemic represented a highly saturated change environment marked not only by technology acceleration, but social, economic, and health volatility. This unstable landscape may have affected people's reactions to otherwise innocuous events, like using new systems at work. Thus, it may be interesting to conduct a similar study during another, more constant time period.

The research comprised a number of strengths as well. First, the research asked participants to respond to a variety of questions regarding how they feel immediately, instead of retrospectively. This immediate, in-situ research is less prone to recall biases and helps us to obtain a more accurate, representative snapshot of phenomena taking place at the current time. In addition, the time-lagged nature of the research allowed us to trace responses over time as opposed to at a single moment in time, and see how responses may evolve or stay the same across time periods. Finally, the research comprised of both quantitative and qualitative components. The qualitative complement provides additional richness to the study and allows us to uncover themes and phenomena regarding age-diverse workforces and technology change that were not originally predicted.

CONCLUSION

With the rapid pace at which technology changes, and the current labour market including workers across many distinct generations, including Baby Boomers, Gen X, Millennials, and most recently Gen Z, organizational behaviour and information technology researchers alike are attempting to identify drivers behind technology adoption and acceptance behaviours, and to determine whether age plays a role. Simply put, researchers are trying to understand if older workers are worse off than younger colleagues when it comes to using technology - and if they are, why? Both the neurological aging perspective (Hawthorn, 2000) and the human capital perspective (de Koning & Gelderblom, 2006) hold that older workers are less adept at using technology and less likely to adopt it, albeit for different reasons. Other perspectives hold that older workers possess different values and motivators than younger workers that must be activated in order to drive acceptance (Morris & Venkatesh, 2000; Venkatesh & Davis, 1996). The findings of this study suggest that the relationship between age and technology is not so simple. Indeed, the results of the study provide support for the stereotype threat perspective and demonstrate that self-perceptions and stereotypes are critical, sometimes insidious, elements that may get in the way of how older workers use technology at work. The insights from the study can help researchers and organizations alike in developing more robust theories around age and technology, and in developing key interventions and mitigation tactics that can help older workers feel more efficacious in their use of technology.

REFERENCES

Abrams, D., Eller, A., & Bryant, J. (2006). An age apart: the effects of intergenerational contact and stereotype threat on performance and intergroup bias. *Psychology and aging*, *21*(4), 691.

Agovino, T. (2020, July 18). COVID-19 deals a dual threat to older workers. Retrieved from https://www.shrm.org/hr-today/news/all-things-work/pages/covid-19-deals-a-dual-threat-to-older-workers.aspx

Ayalon, L., Chasteen, A., Diehl, M., Levy, B., Neupert, S. D., Rothermund, K., ... & Wahl, H. W. (2020). Aging in times of the COVID-19 pandemic: Avoiding ageism and fostering intergenerational solidarity. *The Journals of Gerontology: Series B*.

Bandura, A. (1978). Reflections on self-efficacy. *Advances in behaviour research and therapy*, *1*(4), 237-269.

Barak, B. (1980). Cognitive reference age among the elderly: A new concept for marketing.

Barak, B. (1987). Cognitive age: A new multidimensional approach to measuring age identity. *The International Journal of Aging and Human Development*, *25*(2), 109-128.

Borghans, L., & Ter Weel, B. (2002). *Do older workers have more trouble using a computer than younger workers?*. MERIT, Maastricht Economic Research Institute on Innovation and Technology.

Bozionelos, N. (2001). Computer anxiety: relationship with computer experience and prevalence. *Computers in human behavior*, *17*(2), 213-224.

Callinan, J., & Wong, B. (2020, July 17). Steepening the (adoption) curve: Covid-19 and digital transformation. Retrieved from https://www.advisorperspectives.com/commentaries/2020/07/17/steepening-the-adoption-curve-covid-19-and-digital-transformation.

Chua, S. L., Chen, D. T., & Wong, A. F. (1999). Computer anxiety and its correlates: a meta-analysis. *Computers in human behavior*, *15*(5), 609-623.

Cook, J., & Wall, T. (1980). New work attitude measures of trust, organizational commitment and personal need non-fulfilment. *Journal of occupational psychology*, *53*(1), 39-52.

D'mello, A. (2020, July 23). COVID-19 has sped up digital transformation by 5.3 years, says study. Retrieved from https://www.iot-now.com/2020/07/23/104031-covid-19-has-sped-up-digital-transformation-by-5-3-years-says-study/

Davis F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarferfy, 13*(3), 319-339.

de Koning, J., & Gelderblom, A. (2006). ICT and older workers: no unwrinkled relationship. *International journal of manpower*.

Demiris, G., Rantz, M. J., Aud, M. A., Marek, K. D., Tyrer, H. W., Skubic, M., & Hussam, A. A. (2004). Older adults' attitudes towards and perceptions of 'smart home'technologies: a pilot study. *Medical informatics and the Internet in medicine*, *29*(2), 87-94.

Eastman, J. K., & Iyer, R. (2005). The impact of cognitive age on Internet use of the elderly: an introduction to the public policy implications. *International Journal of Consumer Studies*, *29*(2), 125-136.

Evans, D. (2020, May 19). Post Covid-19, the answer is digital transformation, now what's the question? Retrieved from https://www.forbes.com/sites/daveevans/2020/05/19/post-covid-19-the-answer-is-digital-transformation-now-whats-the-question/#3c69d0f93643.

Friedberg, L. (2003). The impact of technological change on older workers: Evidence from data on computer use. *ILR Review*, *56*(3), 511-529.

George, B. U. C. Ă. Ţ. A. (2016). Organizational Change Management: Part Of The Management Strategy. *Revista Economică*, *68*(5).

Goh, J. O., & Park, D. C. (2009). Neuroplasticity and cognitive aging: the scaffolding theory of aging and cognition. *Restorative neurology and neuroscience*, *27*(5), 391-403.

Hartzel, K. (2003). How self-efficacy and gender issues affect software adoption and use. *Communications of the ACM*, *46*(9), 167-171.

Hawthorn, D. (2000). Possible implications of aging for interface designers. *Interacting with computers*, *12*(5), 507-528.

Heinssen, R.K., Glass, C.R., & Knight, L.A. (1987). Assessing computer anxiety: Development and validation of the Computer Anxiety Rating Scale. *Computers in Human Behavior, 3,* 49-59.

Heinz, M. S. (2013). Exploring predictors of technology adoption among older adults.

Homburg, C., Wieseke, J., & Kuehnl, C. (2010). Social influence on salespeople's adoption of sales technology: a multilevel analysis. *Journal of the Academy of Marketing Science*, *38*(2), 159-168.

Hong, S. J., Lui, C. S. M., Hahn, J., Moon, J. Y., & Kim, T. G. (2013). How old are you really? Cognitive age in technology acceptance. *Decision Support Systems*, *56*, 122-130.

Hughes, R. (2020, 28 April). There's no time for change management during Covid-19, but there must be time to change management. Retrieved from https://www.itproportal.com/features/theres-no-time-for-change-management-during-covid-19-but-there-must-be-time-to-change-management/

Ibaraki, S. (2020, May 15). Digital transformation accelerated in a post-Covid world. Retrieved from https://www.itworldcanada.com/blog/digital-transformation-accelerated-in-a-post-covid-world/430863.

Kane, G.C, Nguyen Phillips, A., Copulsky, J., & Nanda, R. (2020, August 6). A case of acute disruption: Digital transformation through the lens of COVID-19. Retrieved from https://www2.deloitte.com/us/en/insights/topics/digital-transformation/digital-transformation-COVID-19.html

Kübler-Ross, E. (1969), On Death and Dying: What the Dying Have to Teach Doctors, Nurses, Clergy and Their Own Families, Taylor & Francis, New York, NY.

Kulik, C. T., Perera, S., & Cregan, C. (2016). Engage me: The mature-age worker and stereotype threat. *Academy of Management Journal*, *59*(6), 2132-2156.

Laguna, K., & Babcock, R. L. (1997). Computer anxiety in young and older adults: Implications for human-computer interactions in older populations. *Computers in human behavior*, *13*(3), 317-326.

Lamont, R. A., Swift, H. J., & Abrams, D. (2015). A review and meta-analysis of age-based stereotype threat: Negative stereotypes, not facts, do the damage. *Psychology and aging*, *30*(1), 180.

Lester, D., Yang, B., & James, S. (2005). A short computer anxiety scale. *Perceptual and motor skills*, *100*(3), 964-968.

Levy, B. (2000). Handwriting as a reflection of aging self-stereotypes. *Journal of Geriatric Psychiatry*.

Levy, B. (2009). Stereotype embodiment: A psychosocial approach to aging. *Current directions in psychological science*, *18*(6), 332-336.

Levy, B. R., & Leifheit-Limson, E. (2009). The stereotype-matching effect: Greater influence on functioning when age stereotypes correspond to outcomes. *Psychology and aging*, *24*(1), 230.

Lippert, S. K., & Davis, M. (2006). A conceptual model integrating trust into planned change activities to enhance technology adoption behavior. *Journal of information science*, *32*(5), 434-448.

Mahar, D., Henderson, R., & Deane, F. (1997). The effects of computer anxiety, state anxiety, and computer experience on users' performance of computer based tasks. *Personality and individual differences*, *22*(5), 683-692.

Miller, M. (2020, June 26). A pandemic problem for older workers: Will they have to retire sooner? Retrieved from https://www.nytimes.com/2020/06/26/business/retirement-coronavirus.html

Morrell, R. W., Mayhorn, C. B., & Bennett, J. (2000). A survey of World Wide Web use in middle-aged and older adults. *Human factors*, *42*(2), 175-182.

Morris, M. G., & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing work force. *Personnel psychology*, *53*(2), 375-403.

Nazareth, L. (2020, May 18). For older workers, the pandemic employment plunge may be tougher to pull out of. Retrieved from https://www.theglobeandmail.com/business/commentary/article-for-older-workers-the-pandemic-employment-plunge-may-be-tougher-to/

Neupert, S. D., Miller, L. M. S., & Lachman, M. E. (2006). Physiological reactivity to cognitive stressors: Variations by age and socioeconomic status. *The International Journal of Aging and Human Development*, *62*(3), 221-235.

Ng, T. W., & Feldman, D. C. (2012). Evaluating six common stereotypes about older workers with meta-analytical data. *Personnel psychology*, *65*(4), 821-858.

Peters, G. R. (1971). Self-conceptions of the aged, age identification, and aging. *The Gerontologist*.

Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan, B. S., & Tu, Q. (2008). The consequences of technostress for end users in organizations: Conceptual development and empirical validation. *Information systems research*, *19*(4), 417-433.

Rhodes, S. R. (1983). Age-related differences in work attitudes and behavior: A review and conceptual analysis. *Psychological bulletin*, *93*(2), 328.

Richard, O. C., Kochan, T. A., & McMillan-Capehart, A. (2002). The impact of visible diversity on organizational effectiveness: Disclosing the contents in Pandora's black box. *Journal of Business and Management, 8*(3), 265-291.

Rjeily, A. (2020, April 7). Why Covid-19 makes your digital transformation program more critical now. Retrieved from https://www.ey.com/en_ca/digital/why-covid-19-makes-your-digital-transformation-program-more-critical-now.

Roberson, L., & Kulik, C. T. (2007). Stereotype threat at work. *Academy of Management Perspectives*, *21*(2), 24-40.

Rosenbaum, D., More, E., & Steane, P. (2018). Planned organisational change management. *Journal of Organizational Change Management*.

Sadri, G., & Robertson, I. T. (1993). Self-efficacy and work-related behaviour: a review and meta-analysis. *Applied Psychology*, *42*(2), 139-152.

Shedletsky, A.K. (2020, May 12). Due to Covid-19, manufacturing will experience five years of innovation in the next 18 months. Retrieved from https://www.forbes.com/sites/annashedletsky/2020/05/12/due-to-covid-19-

manufacturing-will-experience-five-years-of-innovation-in-the-next-18-months/#34a930b22312.

Simsek, A. (2011). The relationship between computer anxiety and computer self-efficacy. *Online Submission*, *2*(3), 177-187.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. American Psychologist, 52, 613–629.

Steele, C. M., & Aronson, J. (1995). Contending with a stereotype: African-American intellectual test performance and stereotype threat. Journal of Personality and Social Psychology, 69, 797–811.

Swift, M. (2020, May 19). Digital transformation: 5 ways Covid-19 is forcing positive changes. Retrieved from https://enterprisersproject.com/article/2020/5/digital-transformation-positive-changes.

Tams, S. (2011). The role of age in technology-induced workplace stress.

Tescher, J. (2020, April 30). Covid-19 drives digital adoption, but still leaves millions behind. Retrieved from https://www.forbes.com/sites/jennifertescher/2020/04/30/covid-19-drives-digital-adoption-but-still-leaves-millions-behind/#b0a8a3b1469a.

Thatcher, J. B., & Perrewe, P. L. (2002). An empirical examination of individual traits as antecedents to computer anxiety and computer self-efficacy. *MIS quarterly*, 381-396.

Tu, Q., Wang, K., & Shu, Q. (2005). Computer-related technostress in China. *Communications of the ACM*, *48*(4), 77-81.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision sciences*, *39*(2), 273-315.

Venkatesh, V., & Davis, F. D. (1996). A model of the antecedents of perceived ease of use: Development and test. *Decision sciences*, *27*(3), 451-481.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, *46*(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

von Hippel, C., Kalokerinos, E. K., Haanterä, K., & Zacher, H. (2019). Age-based stereotype threat and work outcomes: Stress appraisals and rumination as mediators. *Psychology and Aging*, *34*(1), 68.

Wagner, N., Hassanein, K., & Head, M. (2010). Computer use by older adults: A multi-disciplinary review. *Computers in human behavior*, *26*(5), 870-882.

Wilfong, J. D. (2006). Computer anxiety and anger: The impact of computer use, computer experience, and self-efficacy beliefs. *Computers in human behavior*, *22*(6), 1001-1011.

Williams, S. A., Wissing, M. P., Rothmann, S., & Temane, Q. M. (2010). Self-efficacy, work, and psychological outcomes in a public service context. *Journal of Psychology in Africa*, *20*(1), 43-52.

World Health Organization (2020). *Rolling updates on coronavirus disease (COVID-19).* World Health Organization. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen.

APPENDIX

Appendix A: Survey Questionnaire

(T1)
1. How long have you been working in your current organization? Please specify in years.

2. How long have you been working in your current position? Please specify in years.

3. In what industry is your organization located?
- ❑ Manufacturing
- ❑ Wholesale/retail trade
- ❑ Transportation
- ❑ Information
- ❑ Finance/Insurance
- ❑ Real estate
- ❑ Professional/Scientific/Technical services
- ❑ Education
- ❑ Health care
- ❑ Arts, Entertainment, Recreation
- ❑ Accommodation / Food services
- ❑ Other (please specify) _______________

(T1)
4. In many organizations, people have experienced **changes** that have affected their activities and work conditions. Please indicate the extent to which this has been true of your work in your organization in the past two months.

In the past two months,	Not at all	A little	A moderate amount	A great deal
There have been changes in the tasks I accomplish in my job.	☐	☐	☐	☐
I experienced a change of responsibilities at work.	☐	☐	☐	☐
A change in an organizational policy required me to adapt to new work conditions.	☐	☐	☐	☐
Technological changes have affected my work activities.	☐	☐	☐	☐

(T1)
5. Describe a **recent technological change** that affected your activities. Technological change may mean the introduction of **new software**, **new equipment** or a **change in how existing technology is used**.
- When and why did the change occur?
- What is your current level of comfort with the technology?

(T1, T2. T3, T4) Thinking about **your past week** working with the new technology, please indicate the extent of your agreement with the following statements:

	Strongly disagree				Strongly agree
My learning experience was positive.	☐	☐	☐	☐	☐
Learning the new technology was a good idea.	☐	☐	☐	☐	☐
Overall, I am satisfied with the new technology.	☐	☐	☐	☐	☐
Learning the new technology was enjoyable.	☐	☐	☐	☐	☐
I had adequate resources and tools for learning the new technology.	☐	☐	☐	☐	☐

(T1, T2. T3, T4) During the **past week**:

	Strongly disagree				Strongly agree
I spoke to others with my ideas about the technological change.	☐	☐	☐	☐	☐
I developed and made recommendations concerning how the new technology affects work	☐	☐	☐	☐	☐
I communicated my opinion about the new technology to others, even if they disagreed with me	☐	☐	☐	☐	☐

(T1, T2. T3, T4) As I worked with the technology **this past week,** I felt:

	Not at all	A little	Moderately	Quite a bit	Extremely
Interested	☐	☐	☐	☐	☐
Excited	☐	☐	☐	☐	☐
Strong	☐	☐	☐	☐	☐
Enthusiastic	☐	☐	☐	☐	☐
Proud	☐	☐	☐	☐	☐
Alert	☐	☐	☐	☐	☐
Inspired	☐	☐	☐	☐	☐

Determined	☐	☐	☐	☐	☐
Attentive	☐	☐	☐	☐	☐
Active	☐	☐	☐	☐	☐

(T1)

Your general views of technology at your workplace. Please indicate the extent of your agreement with the following statements:

	Strongly disagree	Disagree	Mildly disagree	Mildly agree	Agree	Strongly agree
The harder I work at learning new technologies, the more confused I get.	☐	☐	☐	☐	☐	☐
I feel confident and relaxed while working with new technologies.	☐	☐	☐	☐	☐	☐
I always have problems working with new technologies.	☐	☐	☐	☐	☐	☐
I can usually manage to solve technological problems by myself.	☐	☐	☐	☐	☐	☐
I have sometimes thought that I am too old to learn new technologies.	☐	☐	☐	☐	☐	☐

(T1)

Please answer the following questions about yourself and your coworkers:

Your gender: Male ☐ Female ☐ Other ☐	**Your age** ______________
Your **coworkers** are **mostly**: Young adults ☐ Midlife adults ☐ Older adults ☐ Diverse ages ☐	

(T4)

Some people find that their age in years (chronological age) is different from the age they feel. Please answer these questions about the **age you feel:** (please check the appropriate box)

	20s	**30s**	**40s**	**50s**	**60s**	**70s**	**80s**	**90s**
I feel as if I am in my…	☐	☐	☐	☐	☐	☐	☐	☐
I look as if I am in my…	☐	☐	☐	☐	☐	☐	☐	☐

I do most things as if I am in my…	☐	☐	☐	☐	☐	☐	☐	☐
My interests are mostly those of people in their…	☐	☐	☐	☐	☐	☐	☐	☐

(T4)
Please indicate whether, **in general,** you could learn a new technology system under a variety of conditions. Please indicate **how confident you are that you could learn the new system if…**

	Not at all confident				Totally confident
…if there was no one around to tell me what to do.	☐	☐	☐	☐	☐
…if I had never used technology like it before.	☐	☐	☐	☐	☐
…if I had only the technology manuals for reference.	☐	☐	☐	☐	☐
…if I had seen someone else using it before trying it myself.	☐	☐	☐	☐	☐
…if I could call someone for help if I got stuck.	☐	☐	☐	☐	☐
…if someone else had helped me get started.	☐	☐	☐	☐	☐
…if I had a lot of time to complete the job for which the new technology was provided.	☐	☐	☐	☐	☐
…if I had just a built-in help facility for assistance.	☐	☐	☐	☐	☐
…if someone showed me how to use it first.	☐	☐	☐	☐	☐
…if I had used similar technology before this one to do the same job.	☐	☐	☐	☐	☐

(T4)
Please provide comments about your experiences with technology over the past month. We may have missed issues that were important to you, and we would be grateful if you could write about them here.

(T1) Are you located in Canada? If not, please specify where you are located.

(T1) Do you have school-age children living at home?

(T1, T2, T3, T4) To understand how you are managing technology over time, we will need to match your email address on all four surveys. Your responses will remain confidential. Please provide your email address:

Appendix B: Qualitative Coding

Axial Code