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Review Article

Associations Between Everyday ICT Usage and (Self-) Ageism: A Systematic Literature Review

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Abstract

Background and Objectives: Both rapid technological changes and (self-)ageism are pervasive challenges of the 21st century, potentially affecting older adults' everyday functioning, health, and well-being. This systematic literature review aimed to synthesize scholarly evidence to determine the associations between everyday information and communication technology (EICT) usage and (self-)ageism as well as potential moderators.
Research Design and Methods: A systematic search was performed in 8 academic databases, covering the time frame from January 1995 to January 2021. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a total of 15 articles met the inclusion criteria and were involved in the analysis. The standardized National Heart, Lung, and Blood Institute's quality assessment tools were used for risk bias.
Results: Several studies demonstrated significant associations between EICT usage and stereotype embodiment ($n = 8$), stereotype threat ($n = 2$), and age discrimination ($n = 3$). Age (group), gender, and motivation were examined as potential moderators.
Discussion and Implications: This review provides initial evidence on the associations between (self-)ageism and EICT usage. It highlights the importance of positive subjective aging perceptions for active EICT usage in older adults, but also emphasizes the detrimental consequences of ageism in EICT learning settings and technology design on older persons' willingness and ability to use EICT. Further ecologically valid and methodologically sound research is needed to better understand both the nature and direction of the association between EICT usage and (self-)ageism.

Keywords: Attitudes toward aging, ICT, Self-perceptions of aging, Subjective age, Technology

Background

Engagement in everyday information and communication technology (EICT), including digital services, such as online banking, video-calling, gaming, or e-shopping, has become a prerequisite for active aging (Malanowski & Cabrera, 2009). While everyday activities increasingly move online and technological skills have become a prerequisite to actively participate in society, some older individuals appear to be left behind (Fang et al., 2019). The coronavirus 2019 pandemic has, both, served as a reminder of existing digital inequalities across populations and a facilitator boosting the uptake of new EICTs in older persons (Seifert et al.,

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2021). Although the "baby boomer" generation is currently the most rapidly growing group of internet adopters (Vogels, 2019), recent survey data demonstrated that in the United States, still, 25% of people aged 65 and older do not engage in internet activities (PEW Research Center, 2021). Reasons for nonuse are diverse; the design of technology, individuals' health, psychological factors, or personal and socioeconomic factors can prevent active EICT usage in later life (e.g., Czaja et al., 2006; Gell et al., 2015; Peine & Neven, 2019). As some disadvantaging factors (e.g., low educational level or low income) accumulate over the life course (Fang et al., 2019), further exploration of the role of structural or societal barriers is called for (Gallistl et al., 2020). More precisely, recent evidence has pointed to a so far underexplored phenomenon, namely the associations between older adults' EICT engagement and self- or other-directed ageism (McDonough, 2016).

Ageism, understood as the "stereotyping, prejudice and discrimination towards people on the basis of age" (Officer & de la Fuente-Núñez, 2018, p. 1), has been found to detrimentally harm everyday functioning, health, and well-being (Chang et al., 2020; Wyman et al., 2018). It affects all areas of everyday life, including work, leisure, social interactions, or services, and hence affects active aging (Swift et al., 2017). Ageism can be directed toward the self and/or others (Levy, 2001). Self-ageism is described as "ageist biases or assumptions held by older adults themselves" (Wyman et al., 2018, p. 200) and manifests when ageism is internalized and turned against oneself (World Health Organization, 2021). Societal messages (e.g., advertisements), physical changes (e.g., first gray hair), or other signs of aging in midlife and later adulthood may trigger perceptions of "feeling old" (Diehl et al., 2015). Yet, both negative self-perceptions of aging and subjectively feeling old have been found to affect on longevity (Westerhof et al., 2014), affect recovery from disability (Levy et al., 2012), and impair health outcomes, such as memory performance and balance (Lamont et al., 2015). It is assumed that self- and other-directed ageism interact and nourish one another (Voss et al., 2018). Therefore, this paper employs the term *(self-)ageism* whenever both phenomena may be at stake. Because both low participation in EICT as well as (self-)ageism can severely impair everyday functioning, health, and well-being, it is crucial to better understand the directionality of the associations as well as factors that moderate these associations.

(Self-)Ageism and EICT

The Risks of Ageism Model (RAM; Swift et al., 2017), a microlevel theory, explains how (self-)ageism may affect on active aging (health, participation, and security) via three potential pathways, namely, stereotype embodiment, stereotype threat, and age discrimination. While Swift and colleagues have discussed RAM within the health care and employment context, an examination of EICT usage through RAM is novel. Stereotype embodiment is described as the internalization of negative stereotypes over the life course, shaping perceptions toward one's own aging (Levy, 2009). This theoretical framework suggests that over the life course, humans assimilate negative age stereotypes from the surrounding environment, while these become self-stereotypes as people grow older (Levy, 2009). For instance, an individual that is exposed to an environment that associates older age with technophobia or incompetence may eventually use less EICTs or have greater performance problems in later life (Köttl, Gallistl, et al., 2021). Comparable to stereotype embodiment, stereotype threat has the power to affect behavior and performance, fueling the self-fulfilling nature of age stereotypes (Steele, 1988). Stereotype threat theory explains the low performance in stereotype-related tasks and activities in a stigmatized person that feels at risk of affirming negative age stereotypes (Steele, 1988). Situations of stereotype threat can lead to direct stress responses impairing cognitive and physical functioning (Schmader et al., 2008). For instance, an older person that participates in a Zoom call with seemingly tech-savvy younger adults may experience stereotype threat when having troubles with the platform. Moreover, stigmatizing elements in the design of a technology (Peine & Neven, 2022) or the media (Köttl, Tatzer, et al., 2021) may activate stereotype threat. At last, actual age discrimination, the unequal treatment based on age, can operate as a hindrance to active EICT engagement (Choi et al., 2020). This may for instance involve lack of internet access based on ageist believes, algorithms advantaging younger individuals, the exclusion of older adults from technology research or design processes, the exclusion of older adults from digital-based health care, lack of EICT training opportunities for older persons or patronizing explanations in EICT learning environments (Köttl, Gallistl, et al., 2021; Mannheim et al., 2019, 2021).

The Associations Between EICT Use and (Self-) Ageism As Well As Potential Moderators

Cutler (2005) was the first to encourage the idea that the association between older adults' technology engagement and (self-)ageism has a reciprocal nature. Indeed, current evidence appears to support both directionalities. Whereas some research clearly identifies (self-)ageism as a barrier to technology adoption (Köttl, Gallistl, et al., 2021; Seifert & Wahl, 2018), other studies emphasize that low EICT involvement contributes to more negative attitudes toward aging and that the design of technology has the power to induce negative aging perceptions (e.g., Caspi et al., 2019).

In addition, various factors, such as gender or age, could potentially moderate the implied associations between EICT use and (self-)ageism. For example, a study by Choi et al. (2020) highlighted that more negative perceptions of aging predict lower levels of internet use in women, while men's internet use was rather associated with the

experience of age discrimination. Furthermore, interaction effects between age groups and ageism varied across gender. However, other so far underexplored factors, such as motivation, self-efficacy, or social support, may moderate the associations between EICT usage and (self-)ageism.

To design and implement successful policies and interventions that help close the digital divide, it is not only important to understand the directionality of the association and potential moderators, but also the mechanisms through which (self-)ageism operates and affects older adults' EICT usage. In line with the RAM (Swift et al., 2017), a distinction into three pathways of ageism, namely, "stereotype embodiment," "stereotype threat," and "age discrimination," potentially reveals mechanisms of how (self-)ageism may be a barrier to active EICT usage in older adults, while low/no EICT usage in later life may affect subjective aging perceptions. Given the deficiencies of the existing evidence, this systematic review aims to examine quantitative evidence from nonexperimental and experimental studies to determine the exact nature of the associations between EICT use and (self-)ageism, potential moderators as well as to provide recommendations for future research.

Method

Search Strategy

The systematic review protocol was registered with Prospero (CRD42021239305). To retrieve empirical studies exploring the associations between EICT use and (self-)ageism, a systematic search of eight academic electronic databases was performed, including PubMed, PsycINFO (EBSCO), Ageline (EBSCO), CINAHL (EBSCO), ERIC (EBSCO), PsycArticles, Academic Search Complete, and SCOPUS. This comprehensive search considered articles published in peer-reviewed journals between January 1, 1995 (when the World Wide Web gained popularity in most Western societies) and January 15, 2021. Search terms included technology-related terms, for instance, "internet" OR "digital divide" AND ageism-related terminology, such as "self-perceptions of ageing" OR "subjective age" (see PubMed search string in Supplementary Material). Search terms, inclusions, and exclusion criteria were discussed and agreed on by all authors.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews (Moher et al., 2009) were followed to select the studies. All titles and abstracts were randomly divided across reviewers. Each article was screened by the first author (H. Köttl) and an additional independent rater (L. D. Allen, I. Mannheim, L. Ayalon) based on the inclusion/exclusion criteria. Disagreement on the inclusion of a study was resolved via discussion between the two reviewers or by a third reviewer where necessary. Full-text articles were assessed for eligibility by the first author and one additional independent rater with regard to the inclusion/exclusion

criteria and disagreements resolved in the same manner. The corresponding author manually screened reference lists of included articles for review employing snowballing technique to identify additional relevant research.

Eligibility Criteria

This systematic literature review included empirical articles that assessed EICT usage and (self-)ageism. Regarding EICT usage, studies had to include at least one variable measuring frequency of EICT use, number of EICTs used, performance, or attitudes toward EICT. Self-ageism was understood as a latent variable, covering constructs such as self-perceptions of aging, attitudes toward aging, expectations regarding aging, or subjective age. This may come forward in assumptions, such as feeling too old to learn to use an EICT (Köttl, Gallistl, et al., 2021). Ageism involves actual age discrimination, for instance, treating an older person differently than a younger person (e.g., Thimm et al., 1998). All measures of moderators mentioned in the context of these associations were involved. Articles published in English, employing quantitative study designs, such as randomized controlled trials (RCTs), cohort studies, longitudinal designs, single-case studies, pre/post designs, case–control designs, or cross-sectional designs, were included. Articles were excluded if evidence was published in a language other than English, if technologies were not accessible for the general population (e.g., special software only used by IT experts) or not relevant for everyday use (e.g., a health care technology only used in clinical settings by professionals), and if papers addressed nonhuman subjects. Furthermore, literature reviews, conference proceedings, as well as studies validating assessment tools were not involved. Qualitative studies were excluded as the original intention was to conduct a quantitative meta-analysis.

Data Extraction and Quality Rating

In line with the PRISMA guidelines, each study eligible for extraction was assessed independently by two authors for risk bias using the standardized National Heart, Lung, and Blood Institute's (NHLBI) quality assessment tools (NHLBI, 2014). Depending on the study design, these tools employ between 9 and 14 criteria to appraise the risk for selection bias, information bias, measurement bias, or confounding. Based on these criteria, each study eventually receives an overall quality rating, distinguishing between "poor," "fair," and "good" quality. A good study is considered to show low risk of bias and high internal validity (e.g., the ability of the study to draw causal conclusions between exposure and outcome, low attrition rates, blinded outcome assessors). A fair study is susceptible to some bias, but its findings can still be perceived as valid to a certain extent, while a poor study has high risk of bias and is considered invalid (e.g., small, convenience samples, no control for confounding variables, using nonvalidated dependent

variables). Differences in rating across raters were resolved through discussions and if unresolved a third member of the team was consulted. Covidence software was used throughout the data search and extraction process. Due to the heterogeneity in study objectives, designs, and outcomes, meta-analyses were not conducted; results are grouped and summarized using a narrative synthesis approach, stratified by methodological quality. In additional, the narrative synthesis was based on the RAM by Swift and colleagues (2017). Articles were attributed to the stereotype embodiment pathway when they measured subjective age, self-perceptions of aging, views on aging, attitudes toward aging, or age stereotypes (Diehl et al., 2015). Research was allocated to the stereotype threat mechanism if authors referred to and assessed stereotype threat. Age discrimination was operationalized as actually measured age discrimination or a different treatment and behavior due to one's age.

Results

A total of 1,021 records were identified through the database search. After removal of duplicates, 580 articles were screened based on title and abstract. From these, 68 studies were assessed in more detail for full-text eligibility, resulting in a total of 12 studies eligible for data

extraction. Additional three studies were identified through snowballing, leading to 15 studies to be included in the narrative syntheses (Figure 1). The research country, aim(s), study design, sample characteristics, measures of ageism and EICT, moderators, and findings of each study are presented in Tables 1 and 2.

The Association Between EICT Use and (Self-) Ageism

To shed light on the associations between EICT usage and (self-)ageism as well as the mechanisms through which (self-)ageism operates, articles were categorized into the three pathways that are known to affect active aging, namely stereotype embodiment, stereotype threat, and age discrimination (Swift et al., 2017).

EICT usage and stereotype embodiment
In total, 11 studies examined stereotype embodiment and EICT usage (see Tables 1 and 2, "Stereotype Embodiment"), although, two papers assessed both, stereotype embodiment and discrimination (Choi et al., 2020; McCausland et al., 2015). Eight out of 11 articles demonstrated a significant association between EICT usage and stereotype embodiment. Two studies did not find such an effect, while one
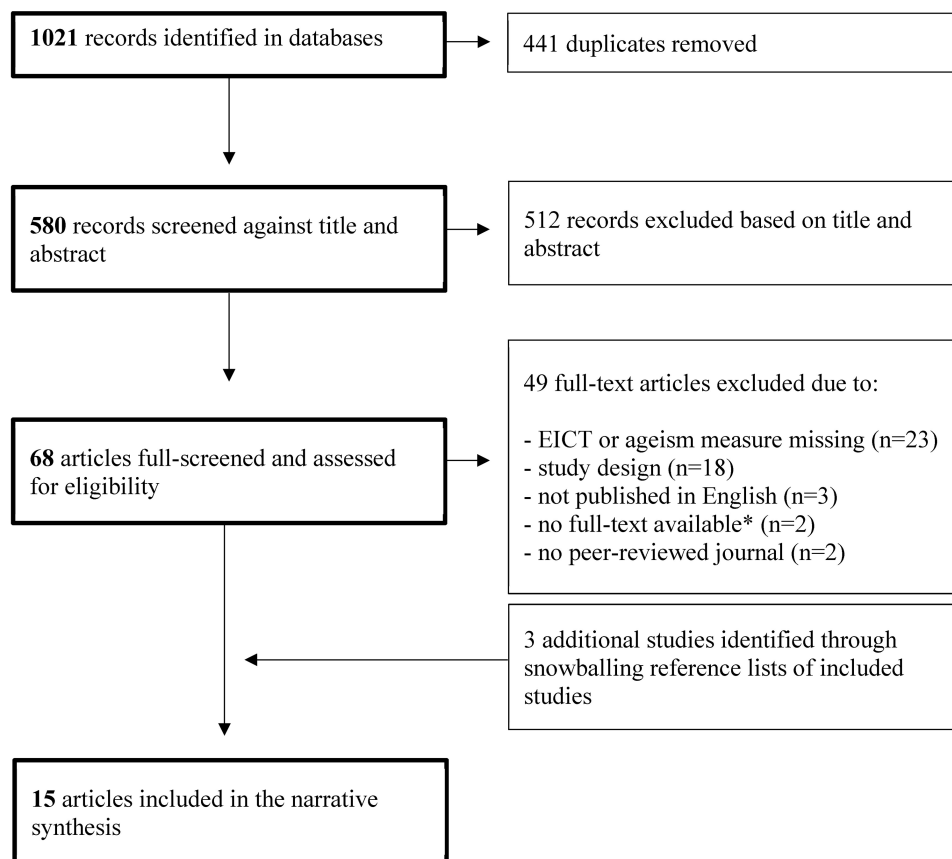

Figure 1. A flowchart describing the systematic review process. *Authors were contacted via e-mail in order to ensure access to full texts. EICT = everyday information and communication technology.

Table 1. Study Characteristics Structured According to the Risks of Ageism Model (Swift et al., 2017): Stereotype Embodiment, Stereotype Threat, and Age Discrimination

Study	Country	Research aim/hypothesis	Study design	Sample characteristics	Risk bias assessment[a]
Stereotype embodiment					
Biermann et al. (2018)	Germany	The influence of individual factors on the acceptance of ultrasonic whistles in home care, with special regard to function and room.	Cross-sectional study (online questionnaire)	N = 270; 60.7% female; age: M = 54.7; SD = 14.67 [18–93]	Fair
Yoon et al. (2016)	United States	Individuals with positive attitudes toward aging would be more likely to use computers and experience lower levels of computer anxiety.	Cross-sectional study (survey questionnaire)	N = 209; 60% female; age: M = 69.6; SD = 7.50 [60–95]	Fair
Cody et al. (1999)	United States	Whether computer anxiety, efficacy, attitude toward aging, perceived social support, and perceived connectivity predict to use different services or functions.	Pre/post study (weekly EICT training program designed for adult learners)	N = 292; 68.8% female; age: M = 80.4; SD = 8.39	Fair
Offermann-van Heek et al. (2021)	Germany	Whether German and Turkish participants differ with regard to potential relationships between lifelogging technology acceptance and attitudes toward aging.	Cross-sectional study (online questionnaire)	N = 118; 73.7% female; age: M = 32.34; SD = 11.28 [17–65]	Fair
Seifert and Wahl (2018)	Switzerland	Feeling younger leads to internet use and should therefore be linked with increased internet use. This relationship holds even after controlling for other relevant predictors in a multivariate model.	Cross-sectional study (representative telephone surveys)	Study 1: N = 1,299; age: M = 77.9 [70–98]; 55.6% female Study 2: N = 1,013; age: M = 74.5 [65–95]; 55.2% female	Fair
Kim et al. (2017)	United States	The effect of age identity on attitude to online sites, examine the impact of this attitude on e-loyalty and investigate the moderating effect of motivational orientation.	Cross-sectional study (survey based on online panel data)	N = 284; 56% female; age: M = 59.8	Poor
Köttl et al. (2021)	Germany	The temporal reciprocal associations of self-perceptions of aging and older adults' EICT use.	Observational study (nationally representative survey)	N = 3,600; 48.9% female; age: M = 61.78	Good
Lagacé et al. (2015)	Canada	The extent to which seniors' endorsement of ageist stereotypes can decrease ICT usage competency and to which ICT usage competency leads to an increase in social capital as well as lowered feelings of social and emotional loneliness.	Cross-sectional study (questionnaire)	N = 172; 66.9% female; age: 14.5% 50–60; 50.6% 61–70; 25.6% 71–80; 8.1% 81–90; 1.2% over 90	Fair
Leedahl et al. (2019)	United States	The effectiveness of an intergenerational service-learning program that utilizes reverse mentoring within higher education, the "Engaging Generations Program."	Pre–post study (online survey)	Students: N = 26; age: M = 21.82; older adults: N = 25 (87 participated); age: M = 72.96	Poor
Stereotype threat					
Mariano et al. (2020)	Portugal	The longitudinal relationship between stereotype threat and computer use in late adulthood.	Observational design (two-wave longitudinal panel data; paper-and-pencil questionnaires)	N = 86; age: M = 78.47; SD = 7.92, 72.1% female	Good

Table 1. Continued

Study	Country	Research aim/hypothesis	Study design	Sample characteristics	Risk bias assessment[a]
Juárez et al. (2018)	Mexico	If technology has an indirect effect on age estimation through supraliminal priming.	RCT (random assignment to one of three groups: technology, aging, and neutral; supraliminal priming through "Sentence Unscrambling Task)"	N = 55, 69% female; age: [19–88]	Poor
Caspi et al. (2019)	Israel	The effect of technology use on the assessment of subjective age across the adult life span, with the assumption that using technology might make older people feel older.	RCT (short priming task on a touch screen tablet); random assignment to a familiar condition, involving a navigation app (Waze), or to a less familiar condition involving a travel reservation app (Booking)	N = 151; 56% female; age: M = 46.04; SD = 19.49 [18–83]	Fair
Age discrimination					
Choi et al. (2020)[b]	United States	Whether perceived ageism is associated with internet use among older adults, and whether age groups and binary gender moderate the association between perceived ageism and internet use.	Cross-sectional study (representative survey data)	N = 5,914; 60% female; age: M = 67.36; SD = 10.72	Fair
Thimm et al. (1998)	Germany	The goal of this study was to add an applied perspective to age stereotyping and patronizing messages by investigating verbal behavior during an instructions task.	RCT (vignettes of persons with different ages and competence levels: competent older adult vs less competent older adult vs age-only-labeled 82-year-old as well as an age-only-labeled 32-year-old person)	N = 120; 50% female; aged 22–28	Fair
McCausland et al. (2015)[b]	United States	If chronological age sparks negative expectancies thus initiating a self-fulfilling prophecy in technology training interactions.	RCT (laboratory experiment; manipulation through exposure to preselected photographs coupled with voice enhancing software)	N = 170; trainers: n = 85; 68,2% female; age: M = 19.43; SD = 1.79; trainees: n = 85; 61,2% female; age: M = 19.57; SD = 2.09	Fair

Notes: EICT = everyday information and communication technology; ICT = information and communications technology; RCT = randomized controlled trial; SD = standard deviation.
[a]Risk bias assessment was based on the standardized National Heart, Lung, and Blood Institute's quality assessment tools (NHLBI, 2014).
[b]Assessed both stereotype embodiment and age discrimination.

Table 2. Study Measures and Findings, Structured According to the Risks of Ageism Model (Swift et al., 2017): Stereotype Embodiment, Stereotype Threat, and Age Discrimination

Study	Measure(s) of (self-)ageism	Measure(s) of EICT usage	Moderators	Findings
Stereotype embodiment				
Biermann et al. (2018)	ATA	Attitude toward technology Technology acceptance Perceived usefulness of technology	Age, gender	ATA affected technology acceptance ($F(3,262) = 3.098$; $p < .05$; $\eta^2 = 0.034$). There was an interaction effect ($F(1,264) = 3.214$; $p < .1$; $\eta^2 = 0.012$) of age and ATA on technology acceptance. Users with negative attitudes accepted ultrasonic whistles more strongly than users with a positive ATA.
Yoon et al. (2016)	ATA	Computer use and computer anxiety	n/a	Those who were using computers had more positive attitudes toward aging ($t(\chi^2) -5.41$, $p < .001$). The level of computer anxiety was found to be significantly reduced by positive attitudes toward aging.
Cody et al. (1999)	ATA	Weekly training with mentor to use the WebTV system	n/a	Internet users had more positive ATA ($F = 2.08$, $p < .001$). ATA were significantly related to staying in the program. More time was spent online when ATA were positive ($\beta = 0.248$, $p = .044$). Flow was significantly influenced by only one predictor variable: ATA ($\beta = 0.445$, $p < .001$).
Offermann-van Heek et al. (2020)	ATA	Short scenario on lifelogging technology Perceived benefits Perceived barriers	n/a	No significant correlations between participants' ATA were found. Instead, the results confirm previous findings that acceptance strongly correlates with the perception of technology-related benefits and barriers.
Seifert and Wahl (2018)	Subjective age	Frequency of internet use	n/a	Subjective age showed a significant relationship with internet use. Older adults who used the internet also felt younger compared with those in the same age group who did not use the internet (Study 1: β (SE) = 0.89 (0.17), $p = .027$; Study 2: β (SE) = 0.52 (0.28), $p = .044$).
Kim et al. (2017)	Age identity Physical age Social age	Attitudes toward online travel websites e-loyalty	Motivational orientation	Psychological age ($\beta = 0.210$, $t = 2.309$, $p < .05$) and social age ($\beta = 0.210$, $t = 2.127$, $p < .05$) negatively influenced older adults' attitude toward travel websites. Motivational orientation significantly moderated the linkage between attitude to travel websites and e-loyalty, with a stronger effect in recreation-oriented motivation ($\beta = 0.929$, $t = 13.121$, $p < .05$) compared to task-oriented motivation ($\beta = 0.601$, $t = 6.093$, $p < .05$).
Köttl et al. (2021)	SPA	EICT	Age group (40–64/65–74/ 75–94)	Nonusers of EICT had less positive SPA on the SPA subscale social loss ($F = 19.68$, $p < .000$). The lagged effect of SPA on EICT engagement was nonsignificant, whereas the lagged effect of EICT engagement on SPA in the domain personal competence was significant ($\beta = -0.06$, $SE = 0.02$, $p < .001$), indicating that greater EICT use predicted more positive SPA related to personal competence 3 years later.
Lagacé et al. (2015)	Endorsement of ageist stereotypes	ICT access and ICT usage competency	n/a	Controlling for differences in access to ICT, seniors' level of agreement with ageist stereotypes partly determined their level of ICT usage competence ($\beta = -0.24$, $p < .05$). The higher the level of agreement with age-based stereotypes, the lower the level of usage competency

Table 2. Continued

Study	Measure(s) of (self-)ageism	Measure(s) of EICT usage	Moderators	Findings
Leedahl et al. (2019)	ATA Students' anxiety about aging	Enjoyment of using technology Problem-solving related to technology	n/a	Students' ATA improved following participation in the Cyber-Seniors program (Cohen's d: −0.6, $p < .01$). Mean scores on two of the questions (i.e., I am comfortable working with older adults (Cohen's d: −0.49, $p < .05$)), and I am confident in teaching older adults how to use technology (Cohen's d: −0.67, $p < .05$) were significantly higher than pretest mean scores. Older adults' post mean scores on the item, I like working with technological devices, showed significant improvements (t-value: −2.61, $p < .01$).
Stereotype threat				
Mariano et al. (2020)	Stereotype threat	Frequency and duration of computer use	n/a	Stereotype threat predicted lower levels of computer use a year and a half later ($\beta = -0.21$, $p = .017$). In turn, computer use was unrelated to the later experience of stereotype threat in this domain.
Juárez et al. (2018)	A measure of ranking age on photos	Unclear	n/a	Although in 47% of the pictures the estimated age differed, technology did not have a significant indirect effect on age estimation through supraliminal priming.
Caspi et al. (2019)	Subjective age	A short task on a touch screen tablet PC	Age	Older people who used technology, especially unfamiliar technology, felt older than they did before using the technology ($t(150)$ 6.38, $p < .001$, Cohen's d: 0.21, 95% CI: 4.36–12.18)
Age discrimination				
Choi et al. (2020)	SPA Perceived age discrimination	Frequency of internet use	Gender and age group	In men, the experience of age discrimination was associated with less internet use ($\beta = -0.33$, $p < .05$). Older men who reported having experienced age discrimination were more likely to use the internet ($\beta = 0.63$, $SE = 0.20$, $p < .01$). In middle-aged men, those with experience of age discrimination were less likely to use the internet. In women, a negative self-perception of aging was significantly associated with less internet use ($\beta = -0.10$, $SE = 0.04$, $p < .05$). Older women with a more negative SPA were less likely to use the internet ($\beta = -0.28$, $SE = 0.07$, $p < .001$), whereas middle-aged women showed stable internet use regardless of their SPA.
Thimm et al. (1998)	Attitudes Toward Aging Scale Quantitative analysis of qualitative categories	Four conditions where students should explain how to use an electronic alarm clock to the target person described	Gender	The results reveal modest differences between the two types of instructions demonstrating trends toward more features of patronizing talk in the instructions toward an 82 than 32 years old target person. Participants more often referred to age-related topics ($F = 3.3$, $p < .08$), age-related deficits ($F = 9.5$, $p < .003$). Feedback was more often requested from an imagined older partner than from an imagined younger partner ($F = 3.7$, $p < .06$). Praising words were used more often in instructions addressed to older recipients than in those with a younger partner ($F = 3.2$, $p < .08$).

Table 2. Continued

Study	Measure(s) of (self-)ageism	Measure(s) of EICT usage	Moderators	Findings
McCausland et al. (2015)	Trainer/trainee expectation based on age manipulation; training interactions and trainer evaluations of trainee performance	Excel macro performance	n/a	Trainers had lower expectations of older trainees than of younger trainees ($F(1.80) = 4.24$, $p = .04$). Lower expectations resulted in the trainer giving poorer evaluations of training. There was not a main effect of perceived trainer age on expected trainer success.

Notes: ATA = attitudes toward aging; CI = confidence interval; EICT = everyday information and communication technology; ICT = information and communications technology; SPA = self-perceptions of aging; SE = standard error. Types of EICTs addressed in articles: internet (41.18%), computer (23.52 %), tablet (5.88%), smartphone (5.88%), assisted living EICT (11.76%), digital alarm clock (5.88%), unspecified technology stimuli (5.88%).

paper measuring the reciprocal associations established evidence for only one directionality. Positive attitudes toward aging/younger subjective aging perceptions were associated with greater EICT usage (Cody et al., 1999; Seifert & Wahl, 2018; Yoon et al., 2016). Negative attitudes toward aging/older subjective aging perceptions were associated with less EICT usage (Choi et al., 2020; Kim et al., 2017), while greater agreement with age stereotypes was associated with lower levels of EICT usage competency (Lagacé et al., 2015). Additionally, more positive attitudes toward aging predicted that an older person completed an EICT training program and managed to learn to use the internet (Cody et al., 1999). A cross-sectional paper demonstrated that individuals with more negative attitudes toward aging were more likely to accept the use of a specific EICT, namely an ultrasonic whistle (Biermann et al. 2018).

Köttl and colleagues (2021) analyzed the reciprocal associations of self-perceptions of aging with EICT engagement, demonstrating that the lagged effect of self-perceptions of aging on EICT engagement over time was nonsignificant, whereas the lagged effect of EICT engagement on self-perceptions of aging in the domain personal competence was significant. Greater EICT engagement, hence, predicted more positive self-perceptions of aging with regard to personal competence 3 years later. At last, Leedahl et al. (2019) highlighted that students who participated in an intergenerational EICT training program showed more positive attitudes toward aging over time, while older adults improved their EICT skills.

EICT usage and stereotype threat

Three studies with conflicting results examined stereotype threat and EICT usage (see Tables 1 and 2, "Stereotype Threat"). Mariano and colleagues (2020) examined the reciprocal associations between stereotype threat and EICT usage, demonstrating that stereotype threat predicted less computer use a year and a half later. Computer use was not associated with experiencing stereotype threat in this domain. Caspi and colleagues (2019), on the other hand, highlighted in their RCT that exposure to EICT, especially to unfamiliar EICT, had the power to induce stereotype threat. After performing an (unfamiliar) EICT task, older adults felt older than they did before engaging with the EICT. One paper of poor quality did not confirm the effect of technology-priming on aging perceptions (Juárez et al., 2018)

EICT usage and age discrimination

Three of the 15 studies indicated a significant association between EICT usage and age discrimination (see Tables 1 and 2, "Age Discrimination"). Greater exposure to age discrimination was found to be associated with less internet use after controlling for relevant confounders (Choi et al., 2020). The measure of age discrimination in this study included variables such as, being treated with less courtesy or respect than other people, receiving poorer service than

other people at restaurants or stores, or being threatened or harassed. Comparably, the RCT by Thimm and colleagues (1998) investigated verbal behavior during an instruction task, requiring participants to explain the use and function of an EICT to one of three older person targets (competent older adults vs less competent older adults vs 82 years old) as well as to a younger person target (32 years old). The results showed modest, but clear differences between the two types of instructions demonstrating age-adapted language and trends toward more features of patronizing talk in the instructions toward an 82 than 32 years old target person. Hence, mere age-labeling of an imagined person resulted in different ways to formulate a partner-oriented instruction on how to use EICT. At last, an RCT by McCausland and colleagues (2015) showed that overall, EICT trainers in EICT courses had more negative expectations of older trainees' competence than of younger trainees and that EICT trainers' age stereotypes and negative expectations toward their own aging affected EICT training outcomes. This was demonstrated in poorer training interactions but also in the more negative performance evaluations of trainees.

Moderators

In total, six studies performed moderator analyses, examining the interaction effects of age (Caspi et al., 2019), age group (Biermann et al., 2018; Choi et al., 2020; Köttl et al., 2021), gender (Biermann et al., 2018; Choi et al., 2020; Thimm et al., 1998), and motivational orientation (Kim et al., 2017). Caspi and colleagues (2019) added the interaction between the application condition (familiar or unfamiliar EICT) and chronological age to the regression analysis and found that there was no significant main effect of EICT application, but that the older the chronological age of the participant, the greater the difference between subjective age before and after the manipulation (toward feeling older).

Biermann and colleagues (2018) analyzed the effects of age group and gender on the acceptance of specific installations and conditions of a home-automated EICT as dependent variables, highlighting a significant main effect of age and a significant interaction effect of age and attitudes toward aging. Specific installations and conditions of an EICT were seen rather positive in middle-aged individuals compared with younger adults. The interaction between gender and attitudes toward aging was not significant. Köttl and colleagues stated to have performed a moderation analysis with age groups yet did not find a significant effect on the reciprocal associations between EICT use and self-perceptions of aging. Also, Choi and colleagues (2020) examined the moderating influence of age group and gender on the association between EICT usage and ageism. The authors demonstrated that in men the experience of age discrimination was associated with less EICT use and found a significant interaction between age group and perceived age discrimination. For women, negative self-perceptions

of aging were associated with less EICT usage while age group also significantly moderated the association. At last, Kim and colleagues (2017) revealed that psychological and social age negatively affected older adults' attitude toward an EICT, while recreation-oriented motivation influenced attitudes toward EICTs more strongly than task-oriented.

Study Designs, Samples, and Outcomes

The narrative analysis involved RCTs (*n* = 4), before–after studies (*n* = 2), two-wave longitudinal observational studies (*n* = 2), cross-sectional observational studies (*n* = 7). The sample size across all 15 studies varied from 55 to 5,914 participants. The majority of studies used convenience samples (e.g., Cody et al., 1999; Mariano et al., 2020) and three studies analyzed large survey data (Choi et al., 2020; Köttl et al., 2021; Seifert & Wahl, 2018). Older adults were defined as 50 and older (Kim et al., 2017; Lagacé et al., 2015), 60 and older (Mariano et al., 2020; Yoon et al., 2016), 65 and older (Choi et al., 2020; Seifert & Wahl, 2018), and 70 and older (Biermann et al., 2018).

Several studies explored EICT usage, EICT competence/performance, attitudes toward EICT, or EICT acceptance as outcome measures (*n* = 8), while other papers assessed (self-)ageism as an outcome measure (*n* = 5). Few studies examined both directionalities (*n* = 2). Included EICT measures showed diverse psychometric properties, with most studies employing self-developed measures using Likert scales. One of the few validated scales was the 10-item subscale of the Loyd–Gressard Computer Attitude Scale by Loyd and Gressard (1984; in Leedahl et al., 2019; Yoon et al., 2016).

The psychometric properties of (self-)ageism measures also varied greatly across articles. Two studies (Choi et al., 2020; Yoon et al., 2016) employed the widely used and validated five-item subscale of the Philadelphia Geriatric Center Morale Scale to assess aging perceptions. In one study (Köttl et al., 2021), self-perceptions of aging were measured through the three subscales from the Age-Cog Scales (Dittmann-Kohli et al., 1997; Steverink et al., 2001; Wurm et al., 2007), which have been validated in the German-speaking context. Another article (Leedahl et al., 2019), employed the Fear of Older People subscale from the Anxiety about Aging scale by Lasher and Faulkender (1993). Perceived age discrimination was assessed by individuals' experience of being mistreated by others due to age (Williams et al., 1997; in Choi et al., 2020). All other studies (*n* = 10) involved either adapted measures based on earlier instruments or created their own instruments for the purpose of the study. Measures of reliability were mentioned in most articles and internal consistency across all articles ranged from low Cronbach's alpha (e.g., Lagacé et al., 2015; Yoon et al., 2016) to high values (Caspi et al., 2019; Cody et al., 1999). Of all studies, 93.3% assessed EICT usage and (self-)ageism separately. Only Mariano et al. (2020) adopted a three-item Likert scale from Marx

and Goff (2005) and Steele and Aronson (1995) to examine stereotype threat in the context of computer usage. This scale showed moderate Cronbach's alpha and a good retest reliability.

Methodological Quality

In line with the PRISMA guidelines, each study was assessed for risk of bias using the study design-specific NHLBI quality assessment tools (2014). Two studies were rated as "good," 10 studies received a score of "fair," and three papers were considered as "poor" (see Table 1). All analyzed studies formulated clear study questions and/or hypotheses. Quality concerns in RCTs were mainly related to deficiencies or lack of information about method of randomization, concealment of treatment allocation, level of blinding, ecological validity, comparability of groups at baseline on important characteristics that may have the potential to affect on outcomes, drop-out rates as well as instrument validity and reliability. Analyzed pre–post studies revealed quality flaws regarding representativeness and eligibility/selection criteria for the study population, clear descriptions, and consistent delivery of the intervention across the study population, blinding of assessors, and loss to follow-up after baseline. The two-wave observational studies revealed few quality concerns, mainly related to follow-up loss after baseline and sample size justification. Cross-sectional studies mainly received scores of "fair" due to the study design's nature of measuring one time point only and its inability to indicate causal relationships.

Discussion

This systematic literature review aimed to examine the associations between EICT usage and (self-)ageism as well as potential moderators. It specifically focused on three pathways (as suggested by Swift et al., 2017) of how (self-) ageism may interact with active aging, namely through stereotype embodiment, stereotype threat, and age discrimination. While several studies within this systematic literature review provided initial evidence indicating significant associations between stereotype embodiment and EICT usage, less research has examined the associations between stereotype threat or age discrimination and EICT usage. Despite the limited number of (high-quality) research, this systematic literature review not only enables first insights into the directionality of the associations between (self-) ageism and EICT usage and potential moderators but also serves as a fundament for methodologically sound and ecologically valid future research.

First of all, this review has demonstrated that "younger" subjective age and more positive self-perceptions of aging are not only significantly related to greater EICT usage, but also associated with remaining longer in an EICT training program, completing an EICT course and managing to learn to use EICTs. This is in line with previous

research demonstrating the impact of self-ageism on various health- and performance-related outcomes (Lamont et al., 2015). It adds to the understanding of self-fulfilling prophecies, by highlighting how a positive aging identity enhances active engagement (Swift et al., 2017), while internalized age stereotypes can tarnish performance on complex tasks (Schmader et al., 2008), for instance, the use of challenging EICTs.

Interestingly, one good quality evidence involved in this systematic literature review indicates the opposite directionality of the association, suggesting that less EICT usage leads to more negative self-perceptions of aging (with regard to personal competence) over time. Hence, being excluded from modern technology negatively affects one's attitude toward aging and the aging experience as such. Facing challenges with basic everyday activities, such as banking, communicating, shopping, or public transportation, may impair one's sense of being in control of life and hamper participation. Indeed, recent evidence has shown that a lower sense of being in control of one's life in older age predicts more negative self-perceptions of aging over time (Luo et al., 2020). However, as only one study supported this directionality, some caution is called for when interpreting these findings.

Biermann et al. (2018) suggested a different pathway, finding that those individuals with more negative attitudes toward aging were more likely to accept the use of an EICT, in this case an ultrasonic whistle. This contrasting finding may be owed to the type of technology under research. While an ultrasonic whistle used at home clearly fulfills the definition of everyday EICT, it also is a health care technology and may remind the user of potential declines related to older age. In public discourses, EICT usage is often connected with a youthful and active lifestyle, while health care or assistive technology is associated with older age (Peine & Neven, 2019). Hence, it is not surprising that older persons with more negative aging perceptions are prone to consider themselves as in need of assistive technology than those who feel young at heart (Claes et al., 2015).

Second, this review emphasized the need to also consider the associations between stereotype threat and EICT usage through a multidirectional lens. While one longitudinal paper of good quality indicated the role of stereotype threat in predicting later-life EICT usage, another experimental article following an RCT design demonstrated the stereotype threat-provoking impact of technology itself. This is in line with qualitative data, highlighting that stigmatizing elements in the design of a certain technology (e.g., the pensioner phone) may induce stereotype threat and directly affect older individuals (Köttl, Gallistl, et al., 2021). While older age is often automatically associated with physical or cognitive declines (Wurm et al., 2007), aging-and-innovation discourses tend to portray technology as the solution to so-called "problems of aging" (Peine & Neven, 2019). Designers', policymakers', and

researchers' internalized age stereotypes may influence what and how EICT is designed, disregarding older individuals' actual needs and interests (Mannheim et al., 2019). In their co-constitution of aging and technology model, Peine and Neven (2020) indeed argue that embedded images of aging influence the "design world" and from there the "technological artifacts" and how these technologies are eventually used.

Third, this literature review has indicated that age discrimination may affect EICT usage in later life, especially in men (Choi et al., 2020) and that embodied age stereotypes in younger trainers can affect EICT training outcomes and lead to discriminatory practices in intergenerational learning settings. These findings align with previous work emphasizing that trainers' negative stereotypes based on trainee characteristics have the potential to impinge on the training quality (Shapiro et al., 2007). Nevertheless, it needs to be acknowledged that this review barely found research on age discrimination or stereotype threat. Only one paper captured age discrimination by assessing objective features of behavior (e.g., age-adapted speech; Thimm et al., 1998). This is in contrast with an earlier literature mapping of ageism in health care, which demonstrated a greater prevalence of papers measuring other-directed ageism than self-directed ageism (Ayalon & Tesch-Römer, 2018). It may be argued that explicit ageism (and discriminatory behavior) in the context of EICT usage is less visible and more challenging to measure compared to attitudes and perceptions. Another explanation may be that age stereotypes related to older adults' EICT usage are so strongly embodied and unchallenged by individuals and societies, leaving low awareness about the occurrence of actual discrimination in this context.

It is crucial to acknowledge that more EICT use in later life should not be considered the sole objective of research on this topic. Understanding the pathways between (self-)ageism and EICT usage is just one contributing factor to addressing the digital divide. Technology use itself is not entirely beneficial, and literature suggests that technology overuse can negatively affect mental health, such as heightened stress, decreased emotional connection, and lowered self-esteem (Scott et al., 2017). Nonusers of technology and the internet may do so for a variety of reasons, and their nonuse can range from passive avoidance to active resistance (Wyatt, 2003). For example, a qualitative study of older independent living residents adopting a monitoring technology found that acceptance of the technology ran on a continuum from eagerness to reluctance, and their priorities differed widely in areas such as feeling in control and privacy concerns (Berridge, 2017). While EICTs can positively affect the lives and well-being of older people, not all older people have the same priorities, needs, and desires related to technology adoption; these differences must be taken into account when evaluating the variables that older adults' (non)use of technology and when framing "good" and "bad" aging (Greubel et al., 2021).

Implications and Future Directions

This system literature review found mainly support for the mechanism of stereotype embodiment (Levy, 2009), emphasizing an association between more negative self-perceptions of aging/older subjective age and low EICT usage. Providentially, previous research has demonstrated the modifiable nature of self-perceptions of aging (Beyer et al., 2019), indicating that a negative aging identity is alterable and self-ageism can be combatted. EICT training interventions for older persons may, hence, specifically target self-ageism by including evidence-based measures to combat ageism in training programs (Burnes et al., 2019). A future research initiative may assess and develop training materials to tackle ageism in EICT learning settings and empower older trainees in their learning process. On the other hand, "train-the-trainer" interventions may be equally important. As indicated in several studies, educating trainers on the potential dangers of EICT-related ageism seems crucial to reduce age-based performance discrepancies and prevent discriminatory practices or stereotype threat in EICT learning settings.

Another effective approach to tackle (self-)ageism is intergenerational contact (Burnes et al., 2019). However, according to the current systematic literature review, ageist behavior in younger adults when teaching a supposedly older adult negatively affected use and learning outcomes. This is in line with recent evidence emphasizing that more physical distance in intergenerational learning contexts decreases technophobia via age-based stereotype threat in older individuals (Xi et al., 2022). Hence, allowing more private space when learning to use a new technology in later life was found to reduce self-ageism. Another research on technology peer-learning has demonstrated that the best outcomes can be reached when a peer is only a little advanced in one or another area (Ma et al., 2020). Considering that younger family members play an essential role in introducing new technology to older adults (Colombo et al., 2015), the potential of train-the-trainer interventions for younger people may be explored in future research.

In the past years, much emphasis was put on enhancing older persons' digital skills through individual trainings (e.g., Cody et al., 1999). Yet, critical gerontologists have warned to consider digital exclusion less as an individual's failure, but rather as a result of individuals, institutions, discourses, and technological devices, acknowledging the power relations around those agents (Gallistl et al., 2020). Indeed, an older adults' willingness or choice to engage in a stereotype-associated life domain, like EICT, may be based on the societal expectation of what individuals of certain age groups are expected to do or not (Krekula, 2009). For instance, if the media depicts older adults as technophobic digital immigrants, some older persons may feel confirmed in their negative EICT-related aging perceptions and remain digitally excluded (Köttl, Tatzer, et al., 2022). Or, if aging-and-innovation markets mainly focus on assistive

or health care technology, societal age stereotypes may be further reinforced, transporting a message of ill-health and dependency related to later life (Peine & Neven, 2019). Technology itself was found to provoke stereotype threat and negative aging perceptions in older persons (Caspi et al., 2019). An effective solution to eliminate ageist EICT design and to overcome the discrepancy of what is being designed and what older adults actually want and need may be participatory design approaches, involving end users into all stages of the design process (Fischer et al., 2019; Mannheim et al., 2019). Furthermore, this review has raised questions about how to best measure EICT usage in older age without provoking stereotype threat unintentionally within study contexts. Greater awareness among aging-and-technology researchers about the potentially confounding effect of (self-)ageism when assessing later-life EICT usage is called for.

Acknowledging that most papers received a quality rating of fair, the findings of this review need to be interpreted with caution. Future studies should further explore the reciprocity of the association between EICT usage and (self-)ageism by employing longitudinal designs and conducting experiments. Moreover, qualitative studies can contribute to the understanding of the associations and indicate potential moderators or mediators. Selection bias may have occurred, considering that several analyses were based on rather small and often unjustified convenience samples. University students, women, and the so-called "young-old" were overrepresented, which limits generalizability of the findings. Future studies should specifically target the diversity of older persons as well as the oldest-old to avoid selection bias.

Another concern relates to the ecological validity of the reviewed studies. It may be argued that some of the studies, especially those following RCT designs, may have created artificial settings, detached from real-world contexts. Future research in the field of technology and (self-)ageism should acknowledge older adults' lifeworlds and focus on technologies that are actually meaningful to older adults (Peine & Neven, 2020). To design methodologically and ecologically sound experimental studies, participatory research approaches are recommended (Fischer et al., 2019; Mannheim et al., 2019).

Another point for discussion is the wide age spectrum when defining older adults. Definitions of older age appeared to vary depending on life domain. While older age is commonly defined according to the retirement age of a certain country, this systematic literature review showed that in the context of EICT older age started at a chronological age of 50. This may further add to the age-based digital divide, segregating populations into digital natives and digital immigrants (Prensky, 2001).

Most EICT measures assessed (self-)ageism on the individual level and relied on self-reports. It may be argued that these measures did not fully capture the multidimensional nature of (self-)ageism in the context of EICT usage.

Moreover, various papers employed single-item scales to assess EICT usage. This neglects the wide spectrum of use and may result in blurred pictures of EICT engagement in later life, reinforcing the ageist notion that older adults do not use technology. Future studies may withdraw from employing binary measurements assessing use or nonuse but rather employ multidimensional instruments that include the wide range of characteristics of EICT usage, such as level of competence or frequency of use, to value the spectrum of EICT usage in later life and avoid stereotyping. Another point of critique is that only one study has measured technology-related ageism directly (Mariano et al., 2020). Acknowledging that stereotypes in specific life domains show greater effects if their content corresponds with the outcome domain (Levy & Leifheit-Limson, 2009), more valid and reliable measurements that directly assess age stereotypes in the context of later-life EICT usage are required.

Finally, few limitations of this current systematic literature review need to be highlighted. This review included peer-reviewed studies published in English language between 1995 and 2020 only. By excluding qualitative data for methodological reasons, this study missed out on primary accounts and narratives given by older adults themselves regarding (self-)ageism and EICT usage. In light of the challenge to quantitively measures EICT usage in real-world settings, a future literature review may also focus on qualitative data. Moreover, this current study primarily aimed to provide a structured synthesis of existing evidence on the associations between EICT usage and (self-)ageism as well as relevant moderators addressed. Future meta-analysis, however, should shed further light on moderating effects and compare the studies on a quantitative level. A meaningful meta-analysis could not have been performed with existing evidence due to the diverse operationalizations and the variety of ageism measurements used, but also because of the potential risk of bias, acknowledging that 13 out of 15 studies received a quality score of "fair" or "poor." To conduct an appropriate meta-analytic synthesis and avoid ambiguous interpretations, an adequate sample is required (Higgins & Green, 2011). Overall, this systematic review has provided a novel examination of the effect between EICT usage and (self-)ageism, highlighting the urgent need for further research.

Conclusion

So far, few studies with low to moderate quality have quantitatively examined the bidirectional associations of (self-)ageism and EICT usage. Despite the limited research available, this systematic literature review provides initial evidence that (self-)ageism hampers EICT engagement, while low EICT engagement has the potential to contribute to more negative aging perceptions. Age group, gender, and motivation were found to moderate this potentially reciprocal association. Accordingly, the results of

this systematic literature review pronounce the importance of positive self-perceptions and attitudes toward aging and a positive age identity for active EICT engagement in later life. Furthermore, the data demonstrate the negative consequences of discriminatory practices in EICT learning contexts as well as the impact of certain technology designs on EICT usage in later life. "Train-the-trainer" initiatives as well as targeted interventions to address (self-)ageism in older adults are needed to enhance EICT use and empower older individuals. Moreover, participatory and inclusive technology design initiatives should be forwarded to decrease ageism in the design of EICT. Technology-and-aging researchers should be aware of (self-)ageism and its potential to bias results when assessing technology usage in older adults. Ageism-free environments are called for in research settings to capture older adults' actual abilities and perceptions toward EICT.

At last, future ecologically valid RCTs and longitudinal studies exploring the reciprocal associations between (self-) ageism and EICT usage in older adults are needed to better understand the directionality of the associations as well as potential moderating factors.

Supplementary Material

Supplementary data are available at *The Gerontologist* online.

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Conflict of Interest

None declared.

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