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*Published in:*  
Journal of Applied Gerontology

*DOI:*  
[10.1177/07334648231163426](https://doi.org/10.1177/07334648231163426)

*Publication date:*  
2023

*Document Version*  
Publisher's PDF, also known as Version of record

[Link to publication in Tilburg University Research Portal](#)

*Citation for published version (APA):*  
Mannheim, I., Varlamova, M., Van zaalen, Y., & Wouters, E. J. M. (2023). The role of ageism in the acceptance and use of digital technology. *Journal of Applied Gerontology*, 42(6), 1283-1294.  
<https://doi.org/10.1177/07334648231163426>

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# The Role of Ageism in the Acceptance and Use of Digital Technology

Journal of Applied Gerontology  
2023, Vol. 42(6) 1283–1294  
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DOI: 10.1177/07334648231163426  
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## Abstract

Technology acceptance models associate older age with lower intention to use digital technology although this assumption is often stereotypically-based and not sufficiently tested with older persons. This study investigated the association of ageism (rather than chronological age) with behavioral intention and actual use of technology within the theoretical framework of the Unified Theory of Acceptance and Use of Technology (UTAUT-2) model. 374 Dutch-speaking participants aged 50–97 completed the UTAUT-2 questionnaire, Expectations Regarding Aging, Attitudes Toward Older Adults Using Technology (ATOAUT-11) and experienced ageism scales. A path analysis found that expectations regarding aging partially mediated the association of age with negative attitudes. Mixed results were found regarding the fit of the new UTAUT-2-Ageism model. Negative ATOAUT moderated the associations of Effort Expectancy, Facilitating Conditions, and Habit with Behavioral Intention to use technology, and the explained variance increased. Further research is warranted to fully identify the potential role of ageism in technology acceptance.

## Keywords

older persons, self-ageism, experienced ageism, technology acceptance, attitudes toward digital technology

### *What this paper adds*

- This is the first study to empirically investigate the role of ageism in the context of technology acceptance models.
- The study broadens the literature on the UTAUT-2 model with older persons and calls for a revision of how chronological age is addressed in relation to technology acceptance.
- The study provides additional support to the most recent innovative research on ageism in the context of digital technology as a unique domain of ageism.

### *Applications of study findings*

- Ageism, and in particular, self-ageism need to be addressed in interventions to increase the use of digital technology by older persons.
- Raising awareness of ageism in the context of digital technology may assist professionals, policymakers, and technology designers in empowering older persons and reducing stereotypical assumptions about the ability of older persons to use digital technology.

## Introduction

Using digital technology (DT) has become an integral, and in many ways, an essential part of our everyday lives. Nevertheless, discrepancies, not to say inequalities, in the use and acceptance of DT are present. Much research has been dedicated to identifying the factors that facilitate or hinder the actual use of DT. Older (chronological) age is often mentioned as a barrier or moderator to using DT, and older persons are highly stereotyped in relation to the use of DT (Cutler, 2005; McDonough, 2016; Quan-Haase et al., 2018). Negative stereotyping is also potentially driven by research

**Manuscript received:** September 3, 2022; **final revision received:** February 23, 2023; **accepted:** February 26, 2023.

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on technology acceptance models, such as the Unified Theory of Acceptance and Use of Technology (UTAUT-2) (Venkatesh et al., 2003, 2012), which associates chronological age (and gender) with (non)intention to use DT. Recent studies, however, emphasize the complexity of the use and adoption of DT by older persons (Greenhalgh et al., 2017; Heerink et al., 2010; Lee & Coughlin, 2015; Peek et al., 2014) and suggest that ageism might have an influencing role in the use and acceptance of DT (Choi et al., 2020; Chu et al., 2022; Köttl et al., 2022; Mannheim et al., 2021; Mariano et al., 2020; Rosales & Fernández-Ardévol, 2020).

Research on technology acceptance has been highly influenced by the seminal work of Davis's (1989) Technology Acceptance Model (TAM) and more recent developments of the UTAUT model (Venkatesh et al., 2003, 2012). These models are based on psychological theories and models, such as Theory of Reasoned Action (Fishbein & Ajzen, 1977) and Self-efficacy theory (Bandura, 1982), and emphasize the cognitive and psychological processes that lead people to express intention to use and actual use behavior of certain technologies. Briefly, according to the UTAUT-2 model, several factors were found to predict the intention to use DT: perceived usefulness and ease of use of technology (based on the TAM model); motivational factors of social influence, norms, and beliefs; habit and facilitating conditions such as receiving help from others. Behavioral intention thereafter, may predict the actual use of DT (as well as habit and facilitating conditions). Age, gender, and experience are presented in the UTAUT-2 model as moderators on the relationship between these factors and behavioral intention and actual use (for illustration, see Figure 1). Subsequently, older age is discoursed as a potential determinant of (non)use.

The UTAUT model is highly influential in research and practice. Two seminal papers by Venkatesh et al. (2003, 2012), for example, have been cited above 50,000 times as of the time of writing this paper. However, the actual role of chronological age and the process of aging on technology acceptance might be under-researched and not well theorized (Sixsmith, 2013; Wanka & Gallistl, 2018), and to some extent, biased and misused. The UTAUT model by Venkatesh et al. (2003) was based on several samples of people working in various organizations (the age of participants was not reported), whereas the UTAUT-2 model (Venkatesh et al., 2012) used a sample with a mean age of 30.7 years. Williams et al. (2015) reviewed studies using the UTAUT model and found that among 174 studies, homogeneous samples were commonly discussed as a limitation. The vast majority of the studies focused on students and young employees, and only 1.7% focused on older people. An additional review by Marangunić and Granić (2015) on 30 years of research on TAM, critically concludes that research on TAM with older persons is based on samples that are not representative of the older population, and mainly focuses on younger and highly educated samples. Additionally, other aspects of aging, such as biological, functional, psychological, and social are

overlooked (Chen & Chan, 2011, 2014). Finally, a meta-analysis by Hauk et al. (2018) found inconsistencies in the correlations between age and perceived usefulness and intention to use DT. It concluded that age is not a well-studied predictor.

Aging is a complex, dynamic and personal process, which leads to diversity in the needs and motivations to use DT. People may have different experiences and attitudes toward aging in general and toward aging and DT in particular. Therefore, acceptance of technology by older persons can be determined by many factors such as actual needs, alternatives to the use of technology, subjective health status, as well as the presence of stigmatization (Peek et al., 2014), and ageism (McDonough, 2016).

Ageism comprises of stereotypes, prejudice, and discrimination toward a person because of their age (Ayalon & Tesch-Römer, 2018). While ageism can be inflicted by others as a form of discrimination, it can also operate on a non-intentional or even implicit level (Levy & Banaji, 2002), and more importantly, be self-inflicted and triggered by specific contexts (Kornadt & Rothermund, 2011) that pose a threat to confirm age-related stereotypes (Swift et al., 2017). DT represents a specific context in which older persons can experience discrimination by others in research and practice (Choi et al., 2020; Chu et al., 2022; Mannheim et al., 2019), as well as apply stereotypes toward themselves as being too old to use DT (Mariano et al., 2020). Indeed, a recent review by Köttl et al. (2022) found significant associations between stereotype embodiment, stereotype threat, experienced ageism, and the use of DT. More so, perceived stereotypes about aging and DT can predict lower use and avoidance of using computers in the future (Mariano et al., 2020), and higher experienced age-discrimination in the past may predict lower use of the internet in the future (Choi et al., 2020).

Significantly, acceptance of DT can be influenced by attitudes and anxiety toward using a specific DT (Heerink et al., 2010). The association between age and technology acceptance may be mediated by cognitive abilities, computer self-efficacy, and computer anxiety (Czaja et al., 2006). A previous study investigating ageism in the context of DT, found a correlation between higher levels of ageism and negative stereotypical attitudes toward older adults' abilities to use digital technology (Mannheim et al., 2021). It was found that healthcare professionals perceived adults as young as 50 as less probable to be able to use health-related DT (comparing to younger age groups). More importantly, social comparison and stereotype activation moderated the correlation between ageism and negative DT-related attitudes. However, this correlation was not tested with a sample of older persons, and the behavioral aspect of ageism (discrimination) was not accounted for.

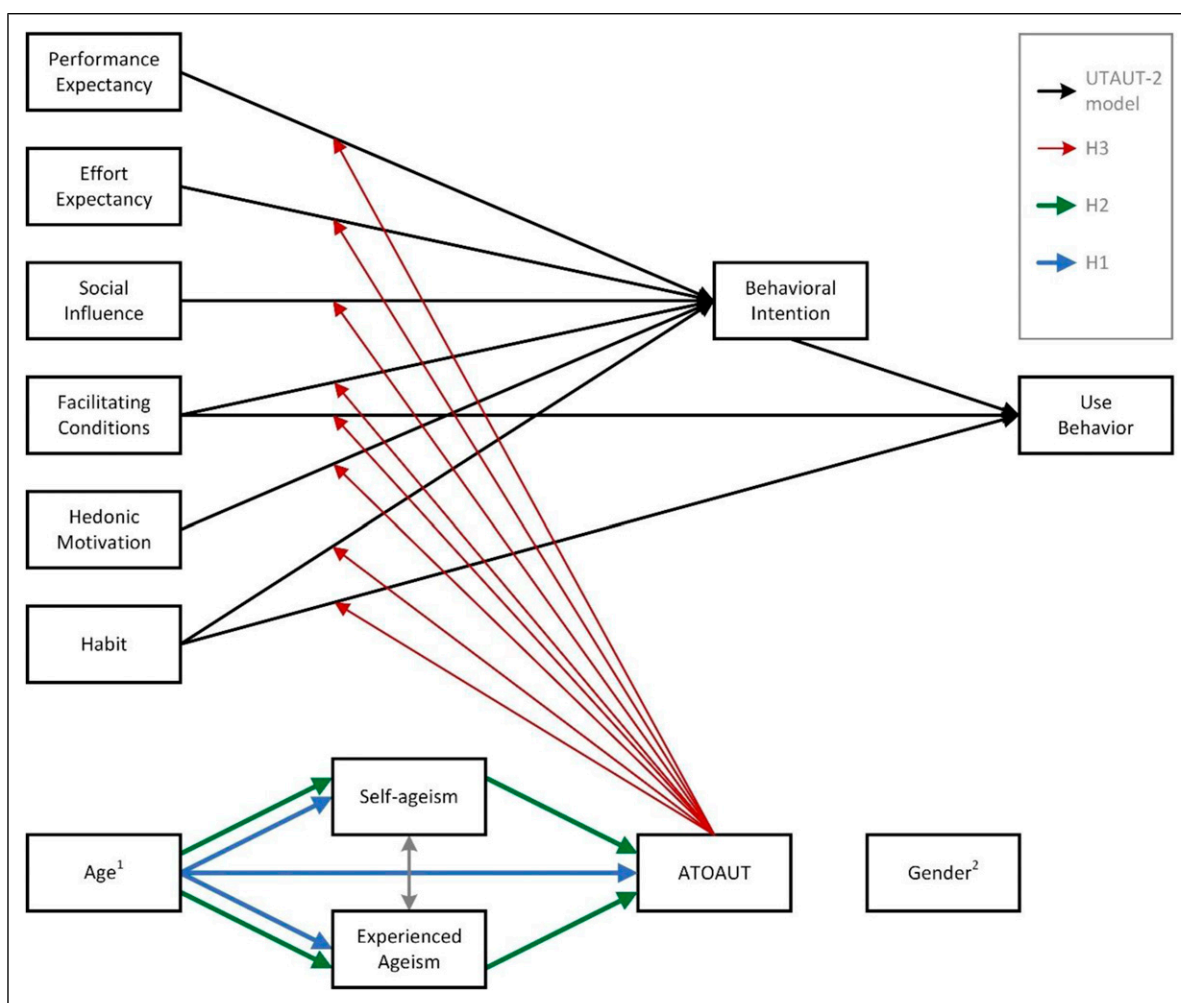
Generally, there seems to be a gap in the literature on the use and acceptance of DT by older persons, as well as the potential role of DT-related ageism in the technology acceptance process. Therefore, this study aims to investigate

whether ageism and negative Attitudes Toward Older Adults' Abilities to Use Technology (ATOAUT) may moderate the intention to use and actual use of DT by older persons within the theoretical framework of the UTAUT-2 model (Venkatesh et al., 2012). Figure 1 visualizes the assumed UTAUT-2-Ageism model and the following pathways and hypotheses that will be tested:

- H<sub>1</sub>: The association of chronological age—as ageism and technology-specific stereotypes are experienced and internalized throughout the life course, older chronological age is expected to be associated with more negative ATOAUT, self-ageism, and experienced ageism.
- H<sub>2</sub>: The mediating effect of (self-)ageism—as previously found, higher levels of self-ageism are expected to be associated with more negative ATOAUT. We

expect that the association of chronological age on ATOAUT will be mediated by self-ageism and experienced ageism.

- H<sub>3</sub>: The moderating effect of ATOAUT on the UTAUT-2 model—notably, the known pathways previously identified by (Venkatesh et al., 2012) between the UTAUT-2 components (performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, and habit) and behavioral intention to use DT, and between facilitating conditions and habit on actual use, will be moderated by negative ATOAUT. More so, after accounting for the mediating effect of ageism (H<sub>2</sub>) and moderating effect of ATOAUT, chronological age, used as a moderator by Venkatesh et al. (2012), will not be a significant moderator of the UTAUT-2 components in the new UTAUT-2-Ageism model.



**Figure 1.** Assumed model of UTAUT-2-Ageism model. <sup>1</sup> The relation between chronological age and ATOAUT is mediated by ageism (ERA-12 and experienced ageism), and age no longer moderates the associations between the UTAUT-2 components and behavioral intention and actual use (as previously assumed by Venkatesh et al. (2012)). <sup>2</sup> Gender is not assumed to have a moderating effect, but is tested and included in the model as it was in the UTAUT-2 model. ATOAUT: Attitudes Toward Older Adults Using Technology; ERA: Expectations Regarding Aging.

## Method

### Participants

The threshold of who is considered old may vary according to context (Kornadt & Rothermund, 2011). For this study, adults aged 50 years and above were sampled, as the concept of “old” in relation to using DT is often conceptualized in research (Nelson-Kakulla, 2020) and perceived by others (Mannheim et al., 2021) as such. This study was conducted in the Netherlands. Thus, participants were required to master the Dutch language. Participants were recruited through older person organizations in the Netherlands, a general practitioner’s office, and social media.

Assessing the minimal sample size for a structural model analysis is challenging, based on many assumptions and is still debated among researchers (Gana & Broc, 2019). Several rules of thumb suggest using at least 250 respondents (Hu & Bentler, 1999). An additional power estimation method for data-model fit is suggested by Hancock and French (2013). Using the assumptions of power level of 0.8,  $\epsilon_1 = .02$  (recommended as the acceptable degree of data-model discrepancy), and  $df = 46$ , a minimal sample size of 351 was estimated.

### Tools and Measurements

*Attitudes Toward Older Adults’ Abilities to Use DT (ATOAUT-11)*. The ATOAUT scale, previously used by Mannheim et al. (2021), consists of ten items relating to stereotypes and prejudice regarding older adults and DT. Following feedback from participating older person organizations, an additional item was added about fear being scammed. Items were ranked on a Likert-type scale from 1 (totally disagree) to 6 (totally agree). Items were later summed without weighting (total scale range 11–66). Higher scores represent more negative attitudes toward older adults’ abilities to use DT (Cronbach’s  $\alpha = 0.774$ ). See Supplemental Appendix 1 for all items.

*(Self-)Ageism*. The Expectations Regarding Aging scale (ERA-12) (Sarkisian et al., 2005) was used to measure general levels of (self-)ageism. The scale consists of twelve items relating to stereotypes and prejudice about aging. Items were ranked on a 4-point ordinal scale (1, definitely false; 2, somewhat false; 3, somewhat true; 4, definitely true) and were later summed without weighting (total scale range 12–48). Higher scores represent more negative expectations regarding aging (Cronbach’s  $\alpha = 0.833$ ).

*Experienced Ageism*. Three items on experienced age-discrimination were adapted from the ageism module in the 4<sup>th</sup> wave of the European social survey (ESS ERIC), 2018). Respondents were asked to indicate on a 5-point scale (ranging from 0 = never to 4 = very often) how often in the

past year they have experienced stereotypes, prejudice or have been treated unfairly, disrespectfully, treated badly, or denied services because of their age (Cronbach’s  $\alpha = 0.835$ ). Items were later summed without weighting (total scale range 0–12).

*Technology Acceptance*. To measure the association of ageism in the context of technology acceptance, items from the UTAUT-2 questionnaire were used. The questionnaire consists of eight different factors (Performance Expectancy [PE], Effort Expectancy [EE], Social Influence [SI], Facilitating Conditions [FC], Hedonic Motivation [HM], Habit [HT], Behavioral Intention [BI] and Use Behavior). Items were linguistically modified to relate to DT in accordance with our definition (see Procedure). The factor of Price Value (used in the UTAUT-2) and the moderator of experience (measured in months) were omitted, as we related to DT in general. Item FC3 (“Digital technology is compatible with other technologies I use”) was omitted as we asked about DT in a broader sense and not about a specific type. Thus, 22 items were measured on a 7-point Likert scale ranging from “strongly disagree” to “strongly agree.” Cronbach’s  $\alpha$  were measured as follows:  $\alpha_{PE} = 0.923$ ,  $\alpha_{EE} = 0.965$ ,  $\alpha_{SI} = 0.899$ ,  $\alpha_{FC} = 0.736$ ,  $\alpha_{HM} = 0.933$ ,  $\alpha_{HT} = 0.696$ ,  $\alpha_{BI} = 0.947$ . Additionally, nine items to measure frequency of actual use of DTs (smartphone, tablet, computer, smartwatch, online banking, online healthcare, online shopping, communication apps, and social media) were added. Frequency was ranked on a 5-item ordinal scale (0 = Never, 1 = about once in several months, 2 = about once a month, 3 = almost every week, 4 = almost every day, 5 = several times a day), and later summed to create a usage index.

Dutch translations of the ATOAUT-11 and ERA-12 were available from previous studies (Mannheim et al., 2021). A translation for experienced ageism was available from the European social survey (ESS ERIC), 2018. Items of the UTAUT-2 questionnaire were translated by the research team using a forward-backward translation procedure, including two independent translators for each step.

### Procedure

This study received ethical approval from the Fontys University of Applied Science ethics research committee (approval file no. Mannheim07072021). Information about the study was distributed online and by participating organizations through their portals, social media, and face-to-face groups. The questionnaire was offered in an online version computerized on Qualtrics and/or in a paper version to ensure people’s participation regardless of technological abilities. In both versions, the first page of the questionnaire included additional information and a consent form. The goal of the study was presented as: learning about the perspectives and attitudes of people aged 50 and above about using DT in everyday life. We defined DT as devices and services



connected to the internet, such as smartphones, tablets, computers, smartwatches, apps, and online services (banking, shopping, healthcare, etc.). This definition and examples were repeated before each measurement tool.

Subsequently, participants filled out demographic information and the main measures of technology acceptance (UTAUT-2) and ageism measurements (ATOAUT-11, ERA-12, and experienced ageism). At the end of the questionnaire, participants were offered a chance to win a 20 Euro gift card (out of 50 available cards) as an incentive for participating. On completion of the data collection, the gift cards were sent to the participants who were randomly selected.

### Analysis

SPSS was used to organize the data and for descriptive statistics. In total, missing data for seven items on the different scales were replaced by the person-mean of the scale (Dodeen, 2003). Path analysis was conducted in two steps, using the R software with the “Lavaan” package for Structural Equation Modeling (SEM). In the first step, the structure of the UTAUT-2 model was examined. In the second step, a new model was tested in which the variables of ATOAUT-11, ERA-12, and experienced ageism were added. The new model, including the mediation of ERA-12 and experienced ageism on the regression between age and ATOAUT (H1 and H2), and ATOAUT as a moderator in the UTAUT-2 model (H3) was tested. For moderation, variables were initially mean-centered as recommended by Cohen et al. (2014). Mediation was tested according to the procedure proposed by Baron and Kenny (1986), and programed according to the procedure by Gana and Broc (2019).

We examined the skewness and kurtosis of the variables' distributions. All variables except experienced ageism did not exceed extreme violation of normality, according to Byrne (2010). Nevertheless, while not considered a severe violation, all UTAUT-2 variables were negatively skewed. Particularly, Behavioral Intention had a higher degree of skewness (1.384) and kurtosis (1.345), with more than 60% of the participants ranking 6 or above on average (on a scale of 1–7). The variable of experienced ageism violated normality (Skewness = 2.040 and Kurtosis = 4.046) with a mean and variance close to zero.

Due to concerns about the violation of normality and skewness of the UTAUT components, we used the Yuan-Bentler robust maximum likelihood (MLR) as the method for parameter estimation (see recommendations by Gana & Broc, 2019) and reported the robust fit indices. The criteria suggested by (Little, 2013) were used to assess the model's fit for the following fit indices: Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis index (TLI), and the Bentler Comparative Fit Index (CFI). Criteria suggested by Gana and Broc (2019) were used to assess the Standardized Root Mean Square Residual (SRMR).

## Results

A total of 453 participants started the questionnaire. 380 (84.1%) of the participants completed the whole questionnaire. Four participants did not report their age, and two more were under the age of 50 and were thus excluded, resulting in a final sample of 374 participants for the analysis (75.5% online and 22.5% paper version). The age of the participants ranged from 50–97 ( $M_{\text{age}} = 69.33$ ,  $SD = 8.59$ ). The sample was balanced gender-wise, with 50.8% male participants. Six participants (1.6%) stated their gender as “not relevant.” Thus, for the purpose of a balanced analysis, we coded within the variable of gender, female and “not relevant” together as value 0, and male as value 1, thus resulting in two groups, each representing approximately 50% of the participants.

Additionally, 57% of participants were retired, 56.2% resided in cities, 69.8% were married or living with a partner, 52.3% had a higher education, and 76.1% indicated that their health does not limit them in daily activities. These characteristics were mainly similar to the general Dutch population, except for education, retirement rates, and prevalence of being married, which were slightly higher in our sample (compared to the Dutch central bureau of statistics data).

Table 1 reports the characteristics and correlations between the main study variables. More negative ATOAUT was found to correlate with higher self-ageism (ERA-12), higher experienced ageism, and lower perceptions of all technology acceptance factors except for social influence. Older chronological age showed initial correlations with more negative ATOAUT and ERA (H1), but not with experienced ageism. Older age was associated with lower perceptions of all technology acceptance factors except for social influence.

### Structural Model of the UTAUT-2-Ageism Model

Table 2 and Figure 2 present the results of the path analysis of the UTAUT-2-only model in step 1, and the UTAUT-2-Ageism model after adding the ageism components of ATOAUT-11, ERA-12, and experienced ageism in step 2. In the second model, the relation of chronological age with negative ATOAUT was mediated by self-ageism (ERA-12), but not by experienced ageism (H2). The indirect effect (0.08) was found to be significant ( $p < .001$ ), thus the association between older age and more negative levels of ATOAUT was mediated by higher levels of self-ageism (ERA-12).

We further examined the structural role of ATOAUT as a moderating factor on the behavioral intention to use and actual use of DT in the UTAUT-2 model (H3). Inspecting and comparing the fit indices between the two models (see Table 2) revealed mixed results. Both models were found to have good fit values (below 0.08) for the SRMR. Examining the RMSEA revealed a better fit for the UTAUT-2-Ageism model, with a narrower confidence interval within the acceptable range (between 0.05 and 0.08), whereas the UTAUT-2-only confidence interval exceeded the mediocre-poor range (higher than

**Table 1.** Mean, Standard Deviations, and Correlations Between Model Variables.

	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	69.33 (8.59)	—											
2. Gender	0.51 (0.50)	.11*	—										
3. ATOAUT	41.22 (8.49)	.25**	.00	—									
4. ERA	32.13 (5.82)	.25**	.19**	.37**	—								
5. Experienced ageism	0.44 (0.74)	.03	-.01	.18**	.23**	—							
6. PE	5.48 (1.53)	-.24**	.09	-.31**	-.15**	-.15**	—						
7. EE	4.60 (1.68)	-.26**	.12*	-.41**	-.18**	-.12*	.76**	—					
8. SI	4.25 (1.75)	-.01	.07	-.05	.09	.08	.35**	.23**	—				
9. FC	5.32 (1.33)	-.27**	.02	-.33**	-.14**	-.23**	.70**	.72**	.28**	—			
10. HM	5.01 (1.64)	-.19**	.07	-.32**	-.11*	-.14**	.72**	.77**	.32**	.71**	—		
11. HT	4.46 (1.44)	-.22**	.06	-.26**	-.03	-.09	.69**	.69**	.34**	.65**	.77**	—	
12. BI	5.70 (1.55)	-.23**	.08	-.33**	-.12*	-.13*	.77**	.71**	.34**	.73**	.76**	.77**	—
13. Actual use	23.97 (7.87)	-.37**	.05	-.29**	-.13*	-.13**	.60**	.65**	.25**	.61**	.61**	.66**	.66**

\* Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

ATOAUT: Attitudes Toward Older Adults Using Technology; ERA: Expectations Regarding Aging; PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; HM: Hedonic Motivation; HT: Habit; BI: Behavioral Intention.

Gender was coded as female and “not relevant” together as value 0, and male as value 1.

**Table 2.** Path Analysis Using the Yuan-Bentler Robust Maximum Likelihood (MLR) Correction Procedure, Comparing the UTAUT-2-Only Model in Step 1 and the UTAUT-2-Ageism Model in Step 2 (N = 374).

	UTAUT-2-only	UTAUT-2-Ageism
Number of model parameters	27	45
R <sup>2</sup> Actual use	0.520	0.520
R <sup>2</sup> Behavioral Intention (BI)	0.763	0.783
R <sup>2</sup> ATOAUT		0.173
Robust RMSEA	0.074	0.065
Robust RMSEA 90% confidence interval: lower – upper	0.045–0.103	0.054–0.076
SRMR	0.011	0.053
Robust Comparative Fit Index (CFI)	0.970	0.860
Robust Tucker-Lewis Index (TLI)	0.907	0.801
<b>Regression standardized coefficients:</b>		
<b>Actual use</b>		
BI	0.22**	0.23**
FC	0.31*	0.31*
HT	0.30 <sup>+</sup>	0.31*
FC X Age	-0.04	-0.03
HT X Age	0.12*	0.13*
FC X Gender	-0.11	-0.10
HT X Gender	0.05	0.04
FC X ATOAUT		-0.02
HT X ATOAUT		0.02
<b>Behavioral Intention (BI)</b>		
PE	0.11	0.09
EE	-0.15	-0.27 <sup>+</sup>
SI	0.11	0.10
FC	0.46**	0.52***
HM	0.09	0.14
HT	0.43*	0.38*
PE X Age	-0.01	-0.03

(continued)

**Table 2.** (continued)

	UTAUT-2-only	UTAUT-2-Ageism
EE X Age	0.01	-0.01
SI X Age	-0.01	-0.00
FC X Age	0.04	0.07
HM X Age	-0.07	-0.05
HT X Age	0.13*	0.09 <sup>+</sup>
PE X Gender	0.19	0.20
EE X Gender	0.12	0.20
SI X Gender	-0.11	-0.08
FC X Gender	-0.27	-0.29 <sup>+</sup>
HM X Gender	0.08	0.05
HT X Gender	-0.11	-0.10
PE X ATOAUT		0.03
EE X ATOAUT		0.11*
SI X ATOAUT		0.02
FC X ATOAUT		-0.15***
HM X ATOAUT		-0.06
HT X ATOAUT		0.14***
<b>ERA</b>		
Age		0.25***
<b>Experienced Ageism</b>		
Age		0.03
<b>ATOAUT</b>		
Age		0.17***
ERA		0.31***
Experienced Ageism		0.1*
† ERA, Experienced Ageism		0.23***
Age X ERA (mediation effect)		0.08***
Age X Experienced Ageism (mediation effect)		0.00
Total effect		0.25***

+*p* < 0.1 \**p* < 0.05 \*\**p* < 0.01 \*\*\**p* < 0.001.

SRMR: Standardized Root Mean Square Residual; RMSEA: Root Mean Square Error of Approximation; ATOAUT: Attitudes Toward Older Adults Using Technology; ERA: Expectations Regarding Aging; PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; HM: Hedonic Motivation; HT: Habit; BI: Behavioral Intention.

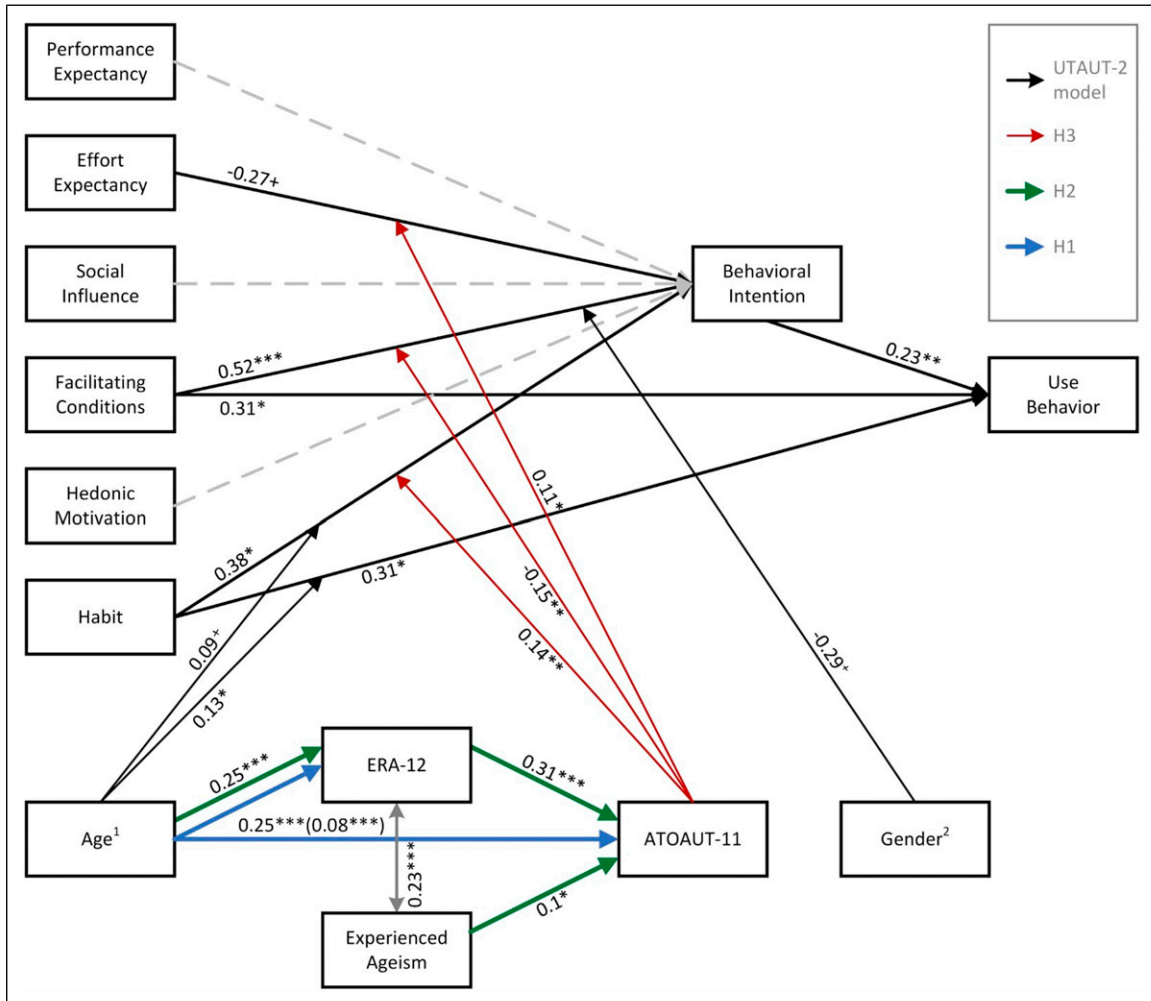
Gender was coded as female and "not relevant" together as value 0, and male as value 1.

0.08). Nevertheless, examining the CFI and TLI revealed that the UTAUT-2-only model had an acceptable to good fit for both indicators (between 0.9–0.99), whereas the UTAUT-2-Ageism model had mediocre to poor fit (below 0.9). The explained variance ( $R^2$ ) of behavioral intention increased in the UTAUT-2-Ageism model (reaching a total of 78.3% explained variance), and the increase was found to be significant ( $F_{(6,349)} = 5.353, p < .001$ ). However, the explained variance of actual use remained the same and did not increase in the new UTAUT-2-Ageism model.

Examining the coefficients and components revealed that in the UTAUT-2-only model, all associations of the UTAUT components on behavioral intention, except for facilitating conditions and habit, were non-significant. No moderation effects of age or gender were found, except for a small moderation effect of age on habit.

Behavioral intention in turn, facilitating conditions, and (marginally) habit were found to be associated with actual use. Moderation of age was once again only found for the association of habit. In the UTAUT-2-Ageism model, similar associations were found between facilitating conditions and habit, and behavioral intention. Additionally, the association of Effort Expectancy was marginally significant. After adding the ageism component, the moderation of age on the relation of habit and behavioral intention diminished. Importantly, negative attitudes (ATOAUT) were found to moderate the relations between effort expectancy, facilitating conditions, and habit, and behavioral intention. The associations with actual use in the UTAUT-Ageism model were similar to the UTAUT-only model, with a slight increase of significance for habit.





**Figure 2.** Path analysis results of the UTAUT-2-Ageism model. Pathways of the factors of the UTAUT-2 model that were originally found significant but were not in this study are highlighted in dotted gray lines. Only significant moderation effects are marked with arrows. All other moderation effects were non-significant.<sup>1</sup> The relation between age and ATOAUT is mediated only by self-ageism (ERA-12).<sup>2</sup> Gender was not assumed to have a moderating effect. One marginally significant moderation effect was found on the association between facilitating conditions and behavioral intention. + $p < 0.1$  \* $p < 0.05$  \*\* $p < 0.01$  \*\*\* $p < 0.001$ . ATOAUT: Attitudes Toward Older Adults Using Technology; ERA: Expectations Regarding Aging; PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; HM: Hedonic Motivation; HT: Habit; BI: Behavioral Intention.

## Discussion

To the best of our knowledge, this is the first study to empirically investigate the role of ageism as a prominent factor in the context of the UTAUT-2 model in particular, and technology acceptance models in general. The results of this study partly support H1, demonstrating simple correlations between older chronological age and more negative Attitudes Toward Older Adults Using Technology (ATOAUT), self-ageism (ERA-12), but not experienced ageism. More so, chronological age was found to correlate with most UTAUT-2 components (all but social influence). If we were to stop at this, we would reiterate a notion heard before by many studies that older age is a barrier to the use of DT. However, this study aimed to explore the potential effect of ageism on the use and

acceptance of DT. Examining H2 partially confirmed our hypothesis that the relation of older age with more negative ATOAUT is partially mediated by self-ageism, but not by experienced ageism. These results corroborate with the findings of Mannheim et al. (2021), and demonstrate that socially learned, internalized stereotypes and prejudice toward older age are directed toward oneself in the context of DT.

While examining the addition of an ageism component to the UTAUT-2 model, we found only partial confirmation for H3. Comparing different fit indices of the two models revealed mixed results (RMSEA showed a better fit for the UTAUT-2-Ageism model, whereas CFI and TLI indices showed a better fit for the UTAUT-2-only model). Nevertheless, several indicators highlight the importance of

considering the UTAUT-2-Ageism model as more fitting for the future of understanding technology acceptance of older persons. First, the explained variance of behavioral intention slightly increased in the new UTAUT-2-Ageism model and the increase was found to be significant. Second, as expected, ATOAUT (rather than chronological age) moderated the associations between effort expectancy, facilitating conditions, and habit, and behavioral intention. However, no moderation effects were found for other factors of performance expectancy, hedonic motivation, and social influence, and no moderation effects of ATOAUT were found on actual use.

Interestingly, in the UTAUT-2-only model, all associations with behavioral intention, except for facilitating conditions and habit, were non-significant. This finding was somewhat surprising considering the robustness of literature indicating that performance expectancy and effort expectancy are the most prominent factors that predict intention to use DT (Venkatesh & Davis, 2000; Williams et al., 2015). Importantly, when adding the ageism component to the model, the association between effort expectancy and behavioral intention increased to marginally significant, and a significant moderation effect of ATOAUT was found. Usability (or ease of use) is central in technology acceptance of older persons (Hauk et al., 2018), and may include aspects such as perceived privacy, safety, ethics, and the invested effort needed in maintenance (Peek et al., 2014). Notably, research of technology acceptance has been hardly tested with samples considered representative of older persons (Marangunić & Granić, 2015). Therefore, differences in the significance of predicting factors across the lifespan may be overlooked. For example, young persons might perceive effort expectancy or ease of use as a factor of time on task (task efficiency), whereas older persons might emphasize the success of solving the task (task effectiveness) (Chen & Chan, 2011). Internalization of stereotypes or concerns about fulfilling age-stereotypes in the context of DT (stereotype threat) might predict lower use of DT in the future (Mariano et al., 2020). Stereotype threat might also be induced or activated by the design of DT and lead to avoidance of using new DTs in order to avoid adverse feelings of being incompetent to use or properly operate a specific DT (Köttl et al., 2021). Importantly, stereotypical images of aging as viewed by designers of DT can be embedded in how DT is designed and consequently affect the perceived usability and actual use (Peine & Neven, 2021).

Interestingly, the strongest predictors of behavioral intention found in this study were facilitating conditions and habit. Both of which were also moderated by ATOAUT. The questions used for facilitating conditions relate to having the necessary knowledge to use DT, having the necessary resources, and being able to receive help from others when having difficulties. Similar to our study, a previous study by Macedo (2017) examining the UTAUT-2 model with older persons found strong effects of facilitating conditions and

habit. However, unlike our study, Macedo (2017) also found strong effects of performance expectancy as well as additional factors. The latter study tested the UTAUT-2 model in relation to the use of computers and the internet. It is possible that our definition of DT was too broad, and future research on the influence of ageism on the use of specific DTs is needed in order to fully understand the influence of central factors such as performance expectancy in the UTAUT-2 model for older persons.

Peek et al. (2019) investigated the stability and frequency of use over time and found six interrelated influencing factors: emotional attachment, need compatibility, cues to use, proficiency to use, input of resources and support. As such, daily use seemed to be influenced by high proficiency to use, receiving support from others, and being able to invest resources and efforts in learning to use DT. The results of our study suggest that these factors might interact with negative and ageist attitudes toward using DT. Besides these moderating effects, we generally found that higher self-ageism, but more importantly, negative ATOAUT, were associated with lower perceptions of all UTAUT-2 components but social influence. Notably, the factor of behavioral intention was negatively skewed, with the majority of participants scoring high, meaning very high intention to use DT. This finding is important for understanding the structural model of the UTAUT-2 as it could imply social desirability in the responses of the participants. More importantly, it might indicate that contra to stereotypes, older persons have positive attitudes toward using DT, as found in previous studies (Nelson-Kakulla, 2020).

### Limitations and Future Implications

This study is one of the first studies to examine ageism in technology acceptance with a diverse sample of older persons. While this sample was not randomly selected and not a fully representative sample of the Dutch society, it was diverse regarding age, place of residence, gender, and education and was found to resemble Dutch society characteristics reasonably well. There is still more need for research on technology acceptance with older persons (Marangunić & Granić, 2015; Williams et al., 2015), as well as making sure that older persons are not excluded from research and design of DT that is intended for their use (Mannheim et al., 2019). Additionally, the sample in this study was restricted to older persons aged 50 and above. Including younger age groups and comparing between different age cohorts may allow to broaden the discussion on the influence of age and life course perspectives. Future studies should attempt to include as diverse as possible samples to test the role of ageism on technology acceptance, including multi-national longitudinal surveys (e.g., SHARE). The technological context of this study was quite broad and defined as DT. Much of the existing research about technology and older persons is in the context of healthcare (Wouters, 2021). Future studies should

therefore investigate technology acceptance of older persons in more specific and various contexts that are relevant for their lives, such as financial, leisure, and social contexts.

Several aforementioned measurements in this study were highly skewed, including behavioral intention. Testing more specific contexts of DTs or developing more complex measurements could increase the variability and validity of this measurement. The measurement of experienced ageism violated normality since most participants reported never experiencing ageism, and the mean and variance were close to zero. Low variability of experienced ageism could imply that participants in our sample did not perceive experiencing ageism. If so, this could indicate that our findings are even more relevant. If in a population that does not experience any ageism, indirect forms of ageism still play a role in technology acceptance, how would this be in a population that does experience ageism or, in general, in more disadvantaged population groups? Alternatively, experienced ageism may also be sensitive to cultural values as well as low (explicit) awareness of the prevalence and manifestations of ageism. Future studies should therefore focus more on the discriminatory aspect of ageism, and explore diverse samples from different countries and different characteristics (e.g., education, income, and social status).

Finally, inspecting the fit indices of the new UTAUT-2-Ageism revealed mixed results. Thus, it cannot be concluded with high confidence that the new UTAUT-2-Ageism is a better model. While our new proposed model was elaborated and parsimonious, investigating models that are less complex, and implementing the aforementioned recommendations regarding sampling and specific context of DT may result in more stable and consistent results.

## Conclusion

Ageism is a multifaceted concept. It can show manifestations in different domains and contexts, such as healthcare, work, and DT, as supported by the findings of this study. Our hypotheses were partially confirmed in the analysis. First, older chronological age was associated with higher self-ageism and more negative attitudes toward the abilities of older persons to use DT (H1). Second, ageism in the context of DT can be self-inflicted. The relation of age and negative attitudes was mediated by self-ageism. Thus, internalized ageism may interfere with the perceptions of older persons toward their own abilities to use DT (H2). Finally, such negative stereotypical attitudes may moderate the relations of other factors with the intention to use and actual use of DT, as found in the UTAUT-2-Ageism model (H3).

Our findings suggest that chronological age alone should not be accounted for as a predictor of intention to use and actual use of DT. As DT is constantly changing and evolving, we claim that regardless of generational differences, tackling DT-related ageism in our society is needed in order to empower older persons and increase the use and adoption of DT

by older persons today and in the future. We advise applying a more critical perspective on technology acceptance models which were not tested with older persons. More research is warranted in order to fully understand the role of ageism in relation to the acceptance of DT and how we can change the way older persons are viewed in relation to DT.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie actions [grant agreement no. 764632; "Euroageism"].

## Disclaimer

All ideas expressed and findings in this article are solely those of the authors and do not represent those of the funding agency.

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## Supplemental Material

Supplemental material for this article is available online.

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