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Research Article

Self-Perceptions of Aging and Everyday ICT Engagement: A Test of Reciprocal Associations

Hanna Köttl, MSc,[1,*] Ella Cohn-Schwartz, PhD,[2] and Liat Ayalon, PhD[1]

[1]Louis and Gabi Weisfeld School of Social Work, Faculty of Social Sciences, Bar-Ilan University, Ramat Gan, Israel. [2]Department of Public Health, Faculty of Health Sciences, Ben-Gurion University of the Negev, Be'er Sheva, Israel.

*Address correspondence to: Hanna Köttl, MSc, Louis and Gabi Weisfeld School of Social Work, Faculty of Social Sciences, Bar-Ilan University, 52900 Ramat Gan, Israel. E-mail: kottl.hanna@biu.ac.il

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Abstract

Objectives: Everyday information and communication technologies (EICTs), involving digital services, such as online shopping, e-banking, and video calling, are perceived to be associated with youth and a modern lifestyle. On the other hand, older adults are often portrayed as technology-alienated, less willing, and incapable of using EICT. The internalization of potentially negative age stereotypes may compromise actual later life engagement and the ability to perform EICT. At the same time, low engagement in EICT may also contribute to negative self-perceptions of aging (SPA), for example, related to physical loss, social loss, and personal competence. This study was, hence, designed to evaluate the temporal reciprocal associations of SPA and older adults' EICT use.

Methods: The article was based on 2 waves (2014 and 2017) from the German Ageing Survey (DEAS), a nationally representative survey of middle-aged and older individuals aged 40 and older. A cross-lagged model (N = 3,600) was estimated to examine the reciprocal associations of SPA and EICT.

Results: 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, indicating that greater EICT engagement predicted more positive SPA related to personal competence 3 years later.

Discussion: These findings encourage researchers and policymakers to put further emphasis on the empowerment of older individuals in their EICT engagement. Interventions that promote lifelong learning and age-friendly environments can enhance a more positive aging experience.

Keywords: Ageism, Internet, Self-ageism, Technology, Views on aging

Older adults are often stereotypically portrayed as resistant to change, technophobic, incapable, and unwilling to adopt new technologies (McDonough, 2016). Some older adults seem to have taken up and internalized these negative age stereotypes and indeed perceive themselves as "too old" or "too stupid at one's age" to successfully engage in everyday information and communication technology (EICT; Kania-Lundholm & Torres, 2015). This overly self-devaluing portrayal of the aging self may be ascribed to individuals' negative self-perceptions of aging (SPA), understood as individuals' subjective views on aging in regard to social, physical, and personal competence (Steverink et al., 2001; Wurm et al., 2007). SPA are not understood as a global or homogeneous construct, but rather comprise a variety of age stereotypes and beliefs in the context of specific life domains (Kornadt & Rothermund, 2011). These are known to significantly affect everyday functioning, health, and well-being (Wurm et al., 2007).

In fact, older adults with negative SPA are more likely to experience physical, social, or cognitive losses when

growing older (Lamont et al., 2015; Schwartz et al., 2020). Moreover, they are prone to act in stereotypical ways, especially when being exposed to environments that activate these often deeply internalized age stereotypes (Levy, 2009). We argue that complex EICT that requires high social, cognitive, and physical capabilities can be seen as such a stereotype-prompting environment, potentially leading to performance problems and disengagement from EICT (Caspi et al., 2019). On the other hand, it may also be true that being excluded from the so-called "technology-society" due to low technology adoption contributes to negative SPA.

To date, the directionality of the association remains unclear. That is, it is still an open question whether internalized negative age stereotypes in the context of technology keep older individuals from engaging in EICT or whether it is low technology engagement that contributes to negative SPA. Accordingly, the current study applies a cross-lagged model to empirically examine the bidirectional relationships between these variables. Understanding the directionality of this potential relationship can guide policymakers' decision making on interventions to enhance older adults' technology engagement and toward awareness campaigns informing about the detrimental effects of age stereotypes on performance and engagement.

Engagement in EICT

For people of all ages, engagement in everyday technology, such as web-based technology, has become necessary to perform a great variety of everyday life activities and therefore crucial for autonomous living and active participation in today's society (Schmidt & Wahl, 2019). EICTs are a subset of everyday technologies that commonly require internet use and have been shown to be rather complex in use (Wallcook et al., 2019). EICTs include mobile phones and smartphones, computers, laptops, and tablets, which each facilitate the capture, storage, and exchange of information (Gagnon et al., 2009). It involves digital services, such as online banking, e-post, online shopping, gaming, social media use, or video calling.

A report from the Pew Research Center showed that only 67% of adults aged 65 and older use the internet as compared with 96% of adults between 30 and 49 years (Anderson & Perrin, 2017). Comparably, only 19% of the European Union-28 population between 65 and 74 years old use the internet for participation in social networks, 45% for sending/receiving emails, 30% for internet banking, 34% for gaming or watching videos, and 43% for finding information about services (Eurostat, 2018). EICT adoption has been explained by the Technology Acceptance Model (Davis, 1989), understanding the intention to engage in technology as based on rational reasoning related to perceived usefulness, ease of use, and overall attitudes toward the technology. Indeed, cohort effects indicate differences in attitudes toward EICT across generations, with older adults having more negative attitudes toward EICT (Lee et al., 2019). While these attitudes toward EICT clearly affect EICT adoption, few studies have explored the association between attitudes toward one's own aging and EICT adoption (Juárez et al., 2018; Kania-Lundholm & Torres, 2015).

The Internalization of Age Stereotypes

The harmful power of age stereotypes and their potential to be internalized by older individuals are well documented (Lamont et al., 2015). According to the Stereotype Embodiment Theory, stereotypes are embodied across the life span and shape views toward one's own aging. Age stereotypes are assimilated from the surrounding environment by younger adults and become self-stereotypes as people age (Levy, 2009). This theoretical framework suggests that lifelong exposure to negative age stereotypes may be eventually internalized in later life by altering health, well-being, and functioning. Stereotypes may act on older adults through a phenomenon called stereotype threat, the underachievement in stereotype-relevant tasks among stigmatized group members when the individual feels at risk of confirming these negative group stereotypes (Steele, 1988). Internalization of negative age stereotypes may lead to the incorporation of these stereotypes into one's self-identity, hence compromising self-esteem. Consequently, individuals tend to avoid stereotype-associated domains (Levy, 2009) or engage in activities that comply with the societal expectation of what a person of a certain age should or should not do (Krekula, 2009), for example, using a digital blood pressure monitor or an assistive technology versus engaging in online dating platforms.

The Impact of SPA on EICT Engagement

Internalized age stereotypes, as manifested in negative SPA, impair performance on cognitive and social tasks that require controlled processing, as well as sensorimotor tasks that require automatic processing (Schmader et al., 2008). Such tasks are, in fact, essential competences for EICT use (Artero et al., 2008). Moreover, embodied age stereotypes seem to not only affect the actual performance of EICT but also influence the initial willingness and choice to engage in particular activities, shaping what activities an older individual considers as meaningful and appropriate at one's age (Krekula, 2009). Following this reasoning, it is assumed that negative SPA in the domains of physical loss, social loss, and personal competence (as defined below) impede EICT engagement.

SPA with regard to physical loss are understood as the perceived decline in physical functioning due to age. Among other scholars, Gell et al. (2015) emphasized the impeding effect of poor physical health on accessing EICT. A longitudinal study, applying bivariate Dual Change Score Models,

revealed that SPA predicted change in physical functioning over time. Hence, an older person who associates older age with age-related physical loss may indeed experience more physical challenges when engaging in EICT (Sargent-Cox et al., 2012). SPA in the domain of social loss are defined as the stereotypical belief that aging is a period of life shaped by social exclusion and withdrawal. As shown by Pikhartova et al. (2016), the reported level of actual loneliness was significantly associated with stereotypes and expectations about loneliness in later life. Some older adults with more negative SPA might be less socially connected in the first place and hence, perceive no need or interest to engage in EICTs for social interaction. SPA related to personal competence embrace aging as a time of individual growth involving psychological elements connected to self-efficacy or sense of mastery. Previous research in the area of subjective age has indeed discovered that the maintenance of a youthful age identity positively contributes to sense of mastery (Infurna et al., 2010). Schmidt and Wahl (2019) even indicated that aside from cognitive abilities, social cognitive factors, such as self-efficacy, perceived obsolescence, and attitudes toward technology, strongly influence performance on EICTs.

The Effect of Low EICT Use on SPA

The reverse causal direction between SPA in physical loss, personal competence, social loss, and EICT engagement is also plausible. Dissatisfying or low engagement in EICT may predict more negative SPA in a highly technologized society where nonusers may feel left behind.

Low engagement in EICT may lead to more negative SPA in regard to physical functioning. This is supported by Caspi et al. (2019) who assessed the effect of technology use on subjective age in community-dwelling Israelis. Using a pre–post manipulation design, they revealed that exposure to technology, especially unfamiliar technology, led to older age perceptions. This may be explained through stereotype threat theory, assuming that exposure to an unfamiliar EICT induces stress and accordingly performance problems. Another study by Hwangbo et al. (2013) indicated how small touch button size and poor spacing among the touch buttons on touchscreen smartphones can significantly impair the finger-pointing performance in older users. Hence, EICTs may have the power to mirror age-related losses and negatively contribute to SPA.

Negative SPA related to social loss may be explained by decreased EICT use. A systematic review by Fang (2019) emphasized the importance of available intergenerational support from children and grandchildren, as well as peers in introducing new EICTs. Those older individuals with low EICT engagement might lack a supportive social network in the first place which is likely to reinforce the belief that older age is a time of loneliness. Furthermore, internet access and use were found to reduce social isolation in older adults (Chen & Schulz, 2016).

At last, low EICT engagement may also influence older adults' SPA with regard to personal competence. In fact, many studies have explored the positive effects of later life technology engagement, suggesting an increase in self-efficacy, self-image, self-esteem, and autonomy (Shapira et al., 2007; Zambianchi & Carelli, 2018). Performance-related challenges due to lack of skills, the complexity of EICT interfaces, and designs combined with a growing societal expectation to use EICT may activate feelings of stress (Czaja et al., 2006) and thus decrease self-efficacy and self-esteem (Caspi et al., 2019). Older nonusers may perceive themselves as not in power of mastering their environment successfully which may further confirm negative age stereotypes.

The Present Study

This study aims to investigate the reciprocal relationship between negative SPA manifested as physical loss, social loss, and personal competence and EICT engagement. The few existing studies about SPA and EICT did not evaluate the potential for simultaneous associations of negative SPA on EICT engagement and vice versa. If at all, they rather investigated each effect separately (Caspi et al., 2019; Juárez et al., 2018). We hypothesized that relatively more negative SPA with regard to physical loss, social loss, and personal competence predict subsequent perceived lower EICT engagement. Additionally, we expected the reversed effects of perceived EICT engagement on SPA in the same three domains. Examining these bidirectional associations can guide future policy decisions and research on enhancing EICT engagement and more positive SPA in later life.

Method

Sample

Data for the analyses were taken from the fifth (2014) and sixth waves (2017) of the German Ageing Survey (DEAS; Klaus et al., 2017) provided by the Research Data Centre of Gerontology (DZA). This nation-wide, representative cohort-sequential study integrates cross-sectional samples with longitudinal samples of community-dwelling adults aged 40 and older. The primary goal of the DEAS is to represent and interpret middle-aged and older Germans' living conditions and realities, targeting both individual development over time and social change (Klaus et al., 2017). The baseline sample (n = 4,838) was randomly drawn in 1996 through a national probability sampling technique applying stratified sampling by age, gender, and region (East and West Germany). A new cross-sectional sample is drawn every 6 years. At each measurement point, participants take part in a 90-min interview and a "drop-off" (= self-report) questionnaire. The present analysis is based on the drop-off questionnaires used in 2014 and 2017 as these waves provide data on EICT use. Of the cross-sectional and

longitudinal samples in 2014, 77% of all study participants completed the drop-off questionnaire constituting the total sample for the present study (n = 7,952). Of these respondents, 4,834 (60.8%) persons participated again in the 2017 drop-off questionnaire. They were more likely to be female, living in West Germany and of medium-level education. Known reasons for withdrawal from the survey are health problems, death, relocation, and denial. Panel attrition was found to have little impact on withdrawal (Klaus et al., 2017). As this study focuses on web-based EICT, those participants who had reported to have internet access and accordingly had replied to the questions on EICT use were involved in the main analysis of interest (N = 3,600). Prior to the interviews, written informed consent was given. According to the German Research Foundation Guidelines (Deutsche Forschungsgemeinschaft), no ethical approval was required.

Measures

SPA were assessed using the three subscales from the Age-Cog Scales addressing the domains: physical loss ($SPA_{physical\_loss}$), social loss (SPA_{social_loss}), and personal competence ($SPA_{personal\_competence}$; Dittmann-Kohli et al., 1997; Steverink et al., 2001; Wurm et al., 2007). These multidimensional scales capture individuals' beliefs regarding age-related losses and gains in various areas. Each subscale consists of four items (e.g., $SPA_{physical\_loss}$: *Aging means to me that I am less healthy*, SPA_{social_loss}: *Aging means to me that I feel lonely more often*, and $SPA_{personal\_competence}$: *Aging means to me that I can still learn new things*). The subscales employ a 4-point Likert scale ranging from (1) *strongly agree* to (4) *strongly disagree*. To facilitate the interpretation of the results, the subscales $SPA_{physical\_loss}$ and SPA_{social_loss} were reverse coded for this analysis. Accordingly, higher values on all scales assessing SPA indicate more negative views. Internal consistency was acceptable for all subscales (2014: α for $SPA_{physical\_loss}$ = 0.77; α for SPA_{social_loss} = 0.72; α for $SPA_{personal\_competence}$ = 0.78).

EICT engagement was self-assessed in the drop-off questionnaire. The participants answered the following question related to EICT that requires internet use: How often do you use the internet for the following purposes? Response options were: contact with friends and relatives, search for new social contacts, search for information, banking business, entertainment, shopping, and creating own contents. The interviewees were offered the possibility to rate each EICT on a seven-item scale from (1) *never* to (7) *daily*. The EICT scores were also recorded; higher values represent higher EICT engagement.

As potential covariates, we included age, gender, civic status (married, living together with spouse; married, but living separated from spouse; single; divorced; and widowed), region (West vs. East Germany), individual monthly net equivalent income (Organisation for Economic Co-operation and Development [OECD] scale), and level of education: low education (9 years of school education at most), medium education (secondary school), and high education (qualifying for university admission). Depressive symptoms were assessed by the Center for Epidemiologic Studies-Depression scale (15 items; Radloff, 1977). Overall health was measured by the SF36 Short Form Health Survey (Ware & Sherbourne, 1992).

Statistical Analysis

In a preliminary analysis, we applied t tests and chi-square tests to compare those with and those without internet access with regard to age, gender, income, education, place of residence, depression, overall health, and SPA. Second, we calculated descriptive statistics and correlations between variables. Next, we used structural equation modeling (SEM) with Mplus Version 8.4 (Muthén & Muthén, 1998–2019) to assess the two-wave cross-lagged autoregressive model outlined in Figure 1 (Finkel, 1995). SEM is a multivariate statistical analysis technique that is employed to analyze structural relationships. SEMs consist of measurement and structural model components. While the measurement model involves the association between underlying observed measures and latent constructs, the structural model establishes the models' structural, or "causal," association between constructs and covariates (Finkel, 1995). This analytic approach enables to simultaneously examine SPA and EICT use as predictors and dependent variables while controlling for measurement biases (e.g., modeled as latent constructs).

Age, gender, education, income, civil status, and region in 2014 were included as covariates due to their known association with technology use (Fang et al., 2019). SPA and EICT engagement were modeled as latent constructs with their items serving as indicators. The covariates were modeled as observed variables. The data set contained a few missing values, with minimal covariance coverage in the variance–covariance matrix of 0.916. The covariance coverage demonstrates the proportion of cases adding values to the calculation of each variance or covariance (Geiser, 2013). To account for missing data, we applied robust

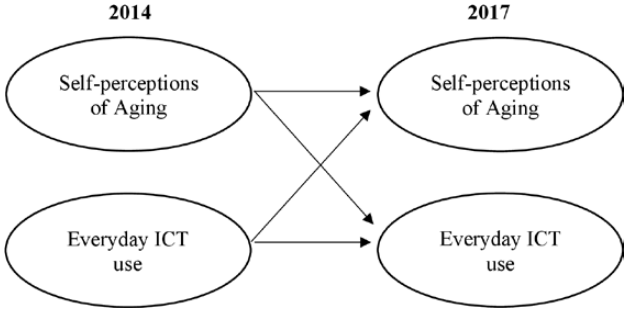

Figure 1. A cross-lagged model for self-perceptions of aging and everyday information and communication technology (EICT) use. Age, gender, civic status, region, income, and level of education were included as covariates.

full-information maximum likelihood estimation. This method provides estimations based on all observations through the imputation of missing values.

The models' goodness of fit was estimated following the recommendations of Hu & Bentler (1999). Besides the chi-square statistic, four approximate fit indices are reported: the Tucker–Lewis index (TLI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). TLI and CFI close to 0.95 and RMSEA of 0.06 or lower indicate reasonably good fit (Hu & Bentler, 1999). The significance level criterion for all other statistical tests was set at 0.05. Variance due to specific measurement occurrences in our two-wave cross-lagged panel model was accounted for by correlating the unique factors across waves (Marsh & Hau, 1996).

To conduct a valid autoregressive model, factorial invariance across time points was considered a prerequisite (Finkel, 1995). Factorial invariance tests the equivalence of measured constructs in two or more independent groups or waves of data collection to guarantee that the same constructs are being assessed in each group or over time. To ensure factorial invariance, we checked to what extent the indicators are related to the same factors in each of the two waves (configural invariance). Second, we assessed the extent to which factor loadings were equal across waves (weak factorial invariance; Meredith, 1993). We created four parcels for the variable EICT by computing the mean of three groups of two items each, while keeping one item unpaired. Parceling, or aggregating items, limits the risk of random errors and improves the reliability of the structural model. It is therefore considered an acceptable procedure when applying SEM with latent variables involving multiple indicators (Little et al., 2002). As an additional sensitivity analysis, we checked for the moderating role of three age groups (40–64/65–74/75–94) to examine whether the associations found operate differently across age groups.

Table 1. Sample Characteristics at Baseline (N = 3,600)

Characteristics	*M* (*SE*)/Frequency (%)
Age (in years)	61.78 (0.041)
Women	1,762 (48.9%)
Education (1–3)	
Low	100 (2.8%)
Medium	1,622 (45.1%)
High	1,879 (52.2.1%)
Income	2,208.16 (0.042)
Civic status (1–5)	
Married, living together	2,712 (75.3%)
Married, living separated	64 (1.8%)
Divorced	340 (9.4%)
Widowed	239 (6.7%)
Single	236 (6.6%)
East Germany	1,051 (29.2%)

Results

In total, 3,600 (74.5%) stated to have access to the internet, while 1,234 (25.5%) had no access. Respondents without internet access were significantly older (F = 34.83; p = .000; [CI = −10.75; −9.49]), had lower levels of education (F = 120.90; p = .000; [CI = 0.30; 0.37]), lower incomes (F = 96.50; p =.000; [CI = 626.69; 809.10]), were more likely to be female (χ^2 = 18.41, df = 1, p = .000), and from East Germany (χ^2 = 93.62, df = 1, p = .000). Moreover, they were significantly more likely to be depressed (F = 8.42; p = .000; [CI = −1.37; −0.61]), functionally impaired (F = 191.30; p = .000; [CI = 9.90; 12.51]), and had less positive SPA on the SPA subscale social loss (F = 19.68; p = .000; [CI = −4.20; −0.44]).

Characteristics of the final sample (those with internet access) are presented in Table 1. Associations between the three SPA subscales: $SPA_{physical\_loss}$, SPA_{social_loss}, and $SPA_{personal\_competence}$ and EICT engagement across the two DEAS waves are highlighted in Table 2. The $SPA_{personal\_competence}$ subscale in 2014 and 2017 and the $SPA_{physical\_loss}$ subscale in 2017 were significantly negatively correlated with EICT use. Table 3 demonstrates intercorrelations among baseline variables including covariates.

Table 2. Means, Standard Errors, and Correlations Among SPA Subscales and EICT Use Across the Two Waves

	M (*SE*)	1	2	3	4	5	6	7	8
1.PC (2014)	1.99 (0.009)								
2. PC (2017)	2.00 (0.009)	0.66**							
3. PL (2014)	2.70 (0.009)	0.40**	0.35**						
4. PL (2017)	2.71 (0.009)	0.35**	0.45**	0.62**					
5. SL (2014)	1.77 (0.009)	0.44**	0.34**	0.41**	0.33**				
6. SL (2017)	1.77 (0.009)	0.37**	0.44**	0.32**	0.42**	0.62**			
7. EICT use (2014)	2.69 (0.015)	−0.17**	−0.19**	−0.02	−0.05**	−0.02	−0.02		
8. EICT use (2017)	2.87 (0.015)	−0.15**	−0.19**	−0.02	−0.06	−0.02	−0.01	0.74**	

Notes: EICT = everyday information and communication technology; PC = personal competence; PL = physical loss; SL = social loss; SPA = self-perceptions of aging; Age-Cog subscales (Dittmann-Kohli et al., 1997; Steverink et al., 2001; Wurm et al., 2007). Overall, 3,600 respondents older than the age of 40 with access to the internet completed the SPA subscales in 2014 and in 2017.
**p < .01.

Table 3. Intercorrelations Among Variables at Baseline (N = 3,600)

Variables	1	2	3	4	5	6	7	8	9	10
1. EICT use										
2. PC	−0.17**									
3. PL	−0.02	0.40**								
4. SL	−0.20	0.44**	0.41**							
5. Age	−0.21**	0.15**	0.07**	−0.01						
6. Gender	−0.16**	−0.04**	−0.05**	0.012	−0.15**					
7. Civic status[a]	0.13**	−0.12**	−0.06**	−0.09**	−0.03	−0.04*				
8. Region[b]	−0.02	0.041*	0.02	−0.05**	−0.04*	0.03	−0.17**			
9. Income[c]	−0.02	−0.00	0.03	0.10**	−0.05**	0.13**	−0.07**	−0.01		
10. Education[d]	0.20**	−0.10**	0.01	−0.08**	0.05**	−0.16**	0.25**	0.12**	−0.05**	

Notes: EICT = everyday information and communication technology; PC = personal competence; PL = physical loss, SL = social loss; Age-Cog subscales (Dittmann-Kohli et al., 1997; Steverink et al., 2001; Wurm et al., 2007).

[a]Civic status: married and living together with spouse, married but living separated from spouse, single, divorced, and widowed.

[b]Region: West vs. East Germany.

[c]Income: individual monthly net equivalent income (Organisation for Economic Co-operation and Development [OECD] scale).

[d]Level of education: low education (9 years of school education at most), medium education (secondary school), and high education (qualifying for university admission).

*p < .05, **p < .01.

Investigating Factorial Invariance

As a first step before testing the autoregressive model, we assessed the measurement model including the two latent variables SPA and EICT use. Each item was loaded into its respective factor while loadings were constrained over time. *Configural invariance* assesses whether the number of factors and the loading pattern are consistent across time. This first model fit the data well, with $\chi^2(df = 420, N = 3{,}600) = 1{,}836.97$, $p < .001$; TLI = 0.96; CFI = 0.97; RMSEA = 0.031 (90% confidence interval [CI] = 0.029–0.032), supporting the presence of configural invariance. Next, we tested *weak factorial invariance* by constraining factor loadings to equality across waves: $\chi^2(df = 432, N = 3{,}600) = 1{,}863.41$, $p < .0001$; TLI = 0.96; CFI = 0.97; RMSEA = 0.030 (90% CI: 0.029–0.032). To confirm the assumption of weak factorial invariance, all factor loadings are required to be the same over time (Hu & Bentler, 1999). Although the resulting models differed significantly from the baseline, with the Satorra–Bentler scaled chi-square difference test result of $\chi^2(12) = 24.30$, $p = .02$, we regarded the results as suggesting weak factorial invariance due to the large sample size and the small magnitude of the statistics. Assuming weak factorial invariance, we eventually proceeded to assess the structural models with equality imposed upon factor loadings across the two waves.

Findings From the Autoregressive Cross-Lagged Model

The hypothesized autoregressive cross-lagged model fit the data well, even after involving the covariates age, gender, education level, income civic status, and region, $\chi^2(df = 609, N = 3{,}600) = 3{,}077.59$, $p < .001$, TLI = 0.94, CFI = 0.95, RMSEA = 0.034 (90% CI: 0.032–0.035). Table 2 summarizes means standard errors and correlations among $SPA_{physical\_loss}$, SPA_{social_loss}, $SPA_{personal\_competence}$, and EICT use across waves. The correlations, R-squared estimates, and structural paths between the content variables of this model are visualized in Figure 2. The effect of SPA on EICT engagement was nonsignificant in the three SPA domains: $SPA_{personal\_competence}$, B (SE) = −0.02 (0.03), p = .57; $SPA_{physical\_loss}$, B (SE) = 0.03 (0.02), p = .23; and SPA_{social_loss}, B (SE) = −0.02 (0.03), p = .45, whereas the lagged effect of EICT use on $SPA_{personal\_competence}$ was significant, indicating that lower levels of EICT use precedes higher levels of negative SPA in regard to personal competence 3 years later, B (SE) = −0.06 (0.02), $p < .001$. The lagged effect of EICT use on $SPA_{physical\_loss}$, B (SE) = −0.02 (0.02), p = .34 and on SPA_{social_loss}, B (SE) = 0.00 (0.02), p = .97 were nonsignificant. In an additional sensitivity analysis, age group (40–64/65–74/75–94) did not significantly moderate the association between SPA and EICT.

Discussion

The present study aimed to investigate the reciprocal associations of SPA with EICT engagement and vice versa. To the best of our knowledge, this is the first study to evaluate these associations in a representative sample involving two waves of survey data. Overall, the findings indicate that decreased engagement in EICT has a potentially negative effect on SPA in older community-dwelling adults in the domain of personal competence 3 years later. We did not find evidence to suggest that enhancing positive SPA leads to greater engagement in EICT over time.

Negative SPA, a Barrier to EICT?

Previous studies have established the impact of SPA on various health and performance outcomes (Wurm et al., 2017).

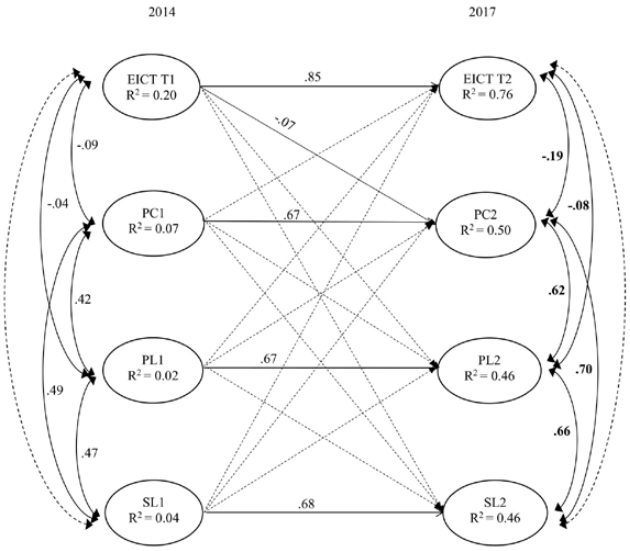

Figure 2. A structural equation model of cross-lagged effects between self-perceptions of aging and engagement in everyday information and communication technology (EICT) with standardized parameters. The solid lines indicate paths statistically significant at $p < .05$. The dotted lines indicate nonsignificant paths. R^2 represents the proportion of explained variance. Age-Cog subscales (Dittmann-Kohli et al., 1997; Steverink et al., 2001; Wurm et al., 2007): PC = personal competence; PL = physical loss; SL = social loss.

It is therefore surprising that our data did not yield support for our first hypothesis, assuming that SPA can act as a barrier to access EICT. This may be attributed to the way the construct of SPA was measured. Similar to our analysis, most earlier SPA research applied a unidimensional approach of SPA, capturing this phenomenon on a positive–negative continuum. In line with the stereotype-matching effect (Levy & Leifheit-Limson, 2009), stereotypes in a certain life domain are expected to have a stronger effect if their content complies with the outcome domain. Questions directly addressing age stereotypes about older adults' technology use may have accordingly supported the strength of the association.

Another potential explanation may be the lack of data in the German Ageing Survey capturing SPA related to cognitive loss. Although the domain of personal competence involved some cognitive components (e.g., learning), participants' SPA with regard to cognition were not extensively covered in our analysis. While cognitive impairments are known to impede EICT performance (Schmader et al., 2008), Leanos et al. (2019) have refuted the ageist assumption that the mere characteristic of "being old" impairs the ability to learn new EICT. Nevertheless, the stereotypical belief that older age is a time of cognitive decline remains widespread, both among younger adults (Seguí et al., 2019) and older populations (Kania-Lundholm & Torres, 2015). We therefore argue that even though we could not support our first hypothesis, awareness campaigns can help to fight the stigma of the "digitally inferior older adult" and empower individuals of all ages in their EICT engagement.

The Role of EICT Engagement in Predicting SPA

EICT use has become crucial to enact the promise of active and healthy aging playing an increasingly important role in alleviating loneliness (Cotten et al., 2013), enhancing autonomy, and accessing important health care or public services in aging individuals (Schulz et al., 2015). As expected in our second hypothesis, we found that lower EICT engagement preceded SPA related to personal competence. This domain comprised age-associated beliefs in one's own capabilities, such as making plans or learning new things. Previous research indicated a similar effect of EICT on self-efficacy, self-esteem, or personal growth, comparable to the personal competence SPA domain. For example, a study by Zambianchi and Carelli (2018) found that favorable attitudes toward internet technologies positively correlated with overall social and psychological well-being, particularly personal growth. Comparably, another small-scale experimental study demonstrated the positive implications of computer and internet use on older adults' well-being and sense of empowerment, contributing to their experience of control and independence (Shapira et al., 2007). Moreover, the fact that the group comparison between internet users (74.5%) and nonusers (25.5%) in our sample showed that those without internet access had significantly less positive SPA may be understood as a validation of our finding.

It is surprising that EICT engagement did not alter SPA in the domain of physical loss, as the design of more complex EICTs has been argued to have the potential to provoke stereotype threat experiences (Fraser et al., 2016). Due to age-related changes (affecting, e.g., eyesight or tactile senses), font size, multiple visual stimuli interfaces, tactile, or auditory feedback functions of some EICT may impede the successful and smooth user experience (Hwangbo et al., 2013). The lack of temporal order in this association may be explained by the fact that many EICTs can actually be adapted to users' specific needs (e.g., font size increased, volume changed, or screens brightened) which may prevent the negative effect of stereotype threat on SPA. However, this is not specifically revealed in our data and requires further exploration. The major focus on EICT in this study (e.g., online banking, online shopping, and information search) rather than health care technology which commonly focuses on physical functioning (e.g., mobile health applications) may be another explanation for why EICT use did not affect SPA related to physical loss. Future studies may tease out effects for different technological applications, involving health care technologies as well as EICT for social interaction or information search.

EICT engagement also did not precede SPA in the domain of social loss. Acknowledging the heterogeneity of older adults, one potential explanation may be that some older individuals simply do not perceive web-based EICT as a meaningful agent to maintain or build new social relations. They may have satisfying existing social contacts or employ different strategies to widen their social networks.

On the other hand, our preliminary group comparison also found that those without internet access had significantly more negative SPA in the domain of social loss. Hence, the association between SPA in regard to social loss and EICT use in individuals without internet access requires further exploration. Equally, the moderating role of age groups in the association of SPA and EICT engagement should be investigated in individuals without internet access. Though our sensitivity test was nonsignificant, alternative findings seem plausible in populations disconnected from the internet.

Moving From the Micro to the Macro Level

Instead of merely researching SPA and EICT from an individual level, societal factors that contribute to low EICT use need to be acknowledged. Disadvantaging policies or stigmatizing elements in the design of technology hinder EICT engagement (Neven & Peine, 2017) and potentially contribute to more negative SPA. Participatory designs and co-constitution projects, involving older individuals, policymakers, designers, engineers, and other practitioners, can help to create innovation policy and technology design that overcome ageist ideas about older adults and their EICT engagement (Neven & Peine, 2017).

Moreover, further awareness about the importance of lifelong learning and how digital exclusion can negatively affect peoples' SPA with regard to personal growth needs to be raised among stakeholders and the general public. A recent study by Leanos et al. (2019) succeeded in breaking the widespread stereotype that older adults are less capable of learning new EICT. Their findings emphasized that cognitive and personal growth is possible at every age, given that environmental and individual learning needs are met. Comparable research initiatives may be taken up by policymakers as to empower older populations and change ageist societal discourses.

Limitations

Due to data availability of the EICT variables only in 2014 and 2017, the proposed association could not be assessed over a longer period of time. This has comprised our ability to examine the reciprocal associations using more advanced methods, such as latent difference scores. Furthermore, this study can allude to temporal order in these reciprocal associations, but not to cause and effect. To identify whether indeed EICT use affects one's SPA or whether the two are explained through a third variable, not addressed in this study, further research should be conducted. Aside from this, future studies may acknowledge potential cross-cultural differences in EICT use and SPA by replicating our analysis in other countries.

The unequal dispersion of opportunities for EICT engagement through social markers, such as age, gender, education, or income, is reflected in our results as such that study participants showed relatively high levels of education and income. The greatest limitation of this study, however, is the exclusion of those without internet access from the autoregressive model, considering that particularly this group had less positive SPA on the subscale social loss and was significantly older, less educated, and more likely to be female. As it is in the nature of survey designs, those who replied with "not having internet access" were automatically excluded from the follow-up questions on EICT use. Acknowledging that such population-based surveys are usually the basis for national and international policy decisions, it may be argued that so-called older "nonusers" are often underrepresented in research and policy. Moreover, also individuals older than 74 years old are often without justification excluded from large surveys on EICT use (Eurostat, 2018). This raises further questions about the equal representation of older age and internet engagement on policy and research levels and may reflect the ageist belief that individuals aged 75 and older do not use the internet. The lack of representation of the oldest-old and "nonusers" in research and policy may impede the effectiveness of policies aiming at closing the digital divide. Future studies should specifically target those without internet access and involve individuals of all ages (Mannheim et al., 2019).

Conclusions and Implications

This study simultaneously examined reciprocal effects and demonstrated that low EICT engagement preceded more negative SPA related to personal competence 3 years later. In contrast, the association between SPA and EICT engagement was nonsignificant. Accordingly, this innovative and methodologically rigorous research calls for policy and technology design initiatives that empower older individuals in accessing EICT. Participatory and co-constitutional approaches are effective measures to enhance EICT adoption. Moreover, further research and interventions that foster lifelong learning and forward ageism-free environments are desired. Such interventions can improve people's SPA in the domain of personal competence and are important in light of the major role SPA play in people's aging process.

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Conflict of Interest

None declared.

Author Contributions

H. Köttl planned the study, performed all statistical analyses, and wrote the paper. E. Cohn-Schwartz provided support in the data analysis and contributed to revising the paper. L. Ayalon helped to plan the study, supervised the data analysis, and revised the manuscript.

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