

# Internet Use and Loneliness among Older Adults: The Moderating Role of Self-Perceptions of ageing

Wenqian Xu<sup>1</sup> and Hanna Köttl<sup>2</sup>

<sup>1</sup> Division Ageing and Social Change, Linköping University, Norrköping, Sweden  
wenqian.xu@liu.se

<sup>2</sup> Faculty of Social Sciences, Bar-Ilan University, Ramat Gan, Israel  
kottl.hanna@biu.ac.il

**Abstract.** Loneliness in advanced age has become one of the societal concerns considering its detrimental effects on physical and mental health of older people. Information and communication technologies show the potential to prevent or tackle loneliness and social isolation among older people. Given a percentage of the older population feeling lonely, loneliness in older age has been increasingly recognized as a stereotype about older people and ageing which shapes self-perceptions of ageing. This cross-sectional study aims to investigate the interaction between older people's Internet use and the level of loneliness, as well as introduce the important role that self-perceptions of ageing may play in this association. The analyses were performed on data of community-dwelling older adults aged 65+ years from the German Ageing Survey. Findings from this study have shown that older people's greater Internet use was significantly associated with a lower level of loneliness; meanwhile, positive self-perceptions of ageing were correlated with a lower degree of loneliness. Additionally, self-perceptions of ageing (in the aspect of personal competence) moderate the relationship between Internet use and loneliness among older people. This paper allows insight into the important moderating role of positive self-perceptions of ageing in the relationship between older people's Internet use and the level of loneliness. This moderating effect hence contributes to the beneficial implications of frequent Internet use on preventing or reducing the level of loneliness. Given the global context of overwhelming facilitation of digital technologies across sectors and vulnerable social groups, it is of significance to empower older adults with negative self-perceptions of ageing to ensure they gain benefits from technological advances, as well as to challenge the prevalent stereotypes about older people and ageing in societies.

**Keywords:** Digital Technology, Image of Ageing, Internet Use, Loneliness, Older People, Self-perceptions of Ageing, Social Contact, Stereotypes, Survey Data.

## 1 Introduction

In recent years loneliness in older age has become a societal concern considering its detrimental effects on physical and mental health [1]. Loneliness is conceptualized as

an index of social well-being and is relevant to the feeling of missing an intimate relationship (emotional loneliness) or missing a wider social network (social loneliness) [2–4]. The present article considers loneliness consisting of two dimensions, social and emotional. Previous studies found that the feeling of loneliness was associated with depression [5], cognitive decline [6], elevated systolic blood pressure [7] and coronary heart conditions [8]. Moreover, loneliness was found as a contributor to reduced well-being, social isolation and exclusion [9, 10]. Based on various country-level surveys loneliness was found to be alarmingly prevalent among older adults [11, 12]. Several longitudinal studies have demonstrated how the prevalence of loneliness among older people remains relatively constant at different time points [13, 14], however, across the individual's lifespan, loneliness is not constant but becomes volatile in older age [15]. Their findings give prominence to the significance of exploring factors that prevent and reduce older people's feeling of loneliness.

Various attempts have been made to prevent or tackle loneliness, including older people-targeted interventions [10, 16]. Increasing attention has been paid to the effects of older people's technology use on reducing the feeling of loneliness and supporting daily activities [17]. Meaningful social interactions of older adults play a significant role in decreasing the level of loneliness [18]. Computer-mediated communication (CMC) technologies have offered affordances for older people in fostering daily interactions and maintaining social contact [19], such as the Internet. A body of evidence showed the positive correlation between more Internet use and lower degrees of loneliness [20–22]; meanwhile, some studies show that extensive online communication may increase the feeling of loneliness due to a potential reduction of real-life relationships [23, 24].

In order to shed further light on the Internet and its potential to decrease loneliness in older adults, the present study adds a new dimension, the role of self-perceptions of ageing, into the discussion. As previously argued, loneliness has been a major concern associated with old age and growing older [25–27]. Likewise, loneliness has appeared to be one of many stereotypes about older people and ageing. Evidence shows that reported level of loneliness was significantly associated with stereotypes and expectations about loneliness in old age [28]. Individuals who believed that loneliness is an unavoidable by-product of older age experienced more loneliness in later life. Additionally, self-perceptions of one's own health has been proven to be associated with social loneliness [21]. In this respect, self-perceptions may play a major role in explaining the occurrence and degree of loneliness in later life.

Accordingly, this paper attempts to: (1) investigate the effects of Internet use for social contact on loneliness in a sample of community-dwelling older adults in Germany; (2) examine the interaction between self-perceptions of ageing and loneliness in community-dwelling older individuals; and (3) investigate the possible role of self-perceptions of ageing as a moderator that accentuates the positive relationship between Internet use and the level of loneliness.

## **2 Previous studies**

### **2.1 Older people's Internet use and loneliness**

It has been recognized by governments and United Nations that promoting the accessibility of ICTs may help with improving the livelihoods of vulnerable populations, such as children, older people and persons of a lower socioeconomic status [29]. A set of policy initiatives have been introduced to promote ICT developments for older populations at the regional and country levels [30–32]. Older people in many countries have gained greater access to digital technologies, particularly in public sites, given state-subsidized information and communication technology (ICT) provisions and other targeted policies. In practice, public services (e.g., healthcare, education, elderly care) and public information have increasingly become web-based, since the Internet demonstrates its potential in improving the provision of public services. Additionally, older people have been considered as a highly relevant population group for online social services, due to the higher likelihood of physical or mental illness associated with older age [33, 34]. In this respect, Internet use has become crucial to access important digital public services, concerning the vision of making Internet relevant to our daily life (including older people) [35, 36].

Unlike the prevalent stereotypical and negative depictions of older adults as technophobic, unwilling or incapable of learning and using new digital technologies [37, 38], various studies have demonstrated that older individuals are indeed willing and capable of learning and using digital technologies, especially for communication purposes [17]. Evidence shows that older people in an adult education center in Barcelona (Spain) extensively use computer-mediated applications [39]. In terms of older people's online activities, older individuals in England and Wales mostly used computers for word-processing activities (e.g., reading and sending emails) [39], while older people in Japan mostly used online message boards to share stories and memories that reinforce their supportive companionship relationships [40]. Internet potentially improves the wellbeing of older people [33].

The ways in which people interact with Internet may be associated with the levels of loneliness in older age. It has been suggested that the use of Internet facilitates social connections and reduces loneliness in older people [21, 22]. The present paper investigates the relationship between older people's Internet use and their perception of loneliness. Therefore, we propose Hypothesis 1:

H1: Greater Internet use is associated with lower reported levels of loneliness in community-dwelling older adults.

### **2.2 Loneliness in older age and self-perceptions of ageing**

Being socially isolated or lonely is one of the myths and stereotypes about older people [41]. Likewise, Loneliness was stereotypically associated with the lower status of older people, lack of meaning, and neglect by relatives in Finnish media [42]. This media representation of loneliness potentially contributes to the formation of stereotypes about

older people. A literature review suggests that a small proportion of older persons aged between 65 and 79 years reported the experience of loneliness; while the prevalence of loneliness is higher among the oldest-old members of society (those age 80 and older) [43, 44]. Even though growing older is often equated with increasing loneliness, this phenomenon does not occur due to age per se, but rather because ageing adults are more likely to experience losses [45], both social and physical.

In respect to potential ageing-related social losses, Weeks [46] argued that loneliness may result from the losses that obstruct the acquisition of desired relationships and the maintenance of existing relationships, given that the possibility of experiencing losses rises as people age. Likewise, Routasalo and Pitkala [47] suggest that widowhood and the loss of a close friend are risk factors of loneliness over the lifespan. Regarding physical losses, hearing loss was mentioned as a cause of isolation, anxiety and depression [48]. Similarly, sensory losses such as hearing or visual impairments may result in increasing communication difficulties and decreasing socialization [49]. These losses contribute to the likelihood of loneliness [50, 51]. In respect to a potential reduction of personal competence in older age, older people are often stereotypically portrayed as incompetent in societies. It was found that older people's self-perception of personal competence was related with their social engagement in paid work and voluntary work [52]. Given that loneliness is entangled with potential loss during the ageing process, self-perceptions of ageing serve as a measurement of the extent that people of advanced age perceive these losses.

Self-perceptions of ageing (SPA) refer to a person's subjective views (positive or negative) on the aspects of ageing; SPA represents societal views on ageing that are internalized throughout the life course [53]. Evidence suggests that SPA are associated with specific health outcomes, affecting functioning wellbeing and longevity [54–57]. Specifically, positive self-perceptions of ageing may contribute to better health and well-being. According to the Stereotype Embodiment Theory, stereotypes and prejudice are internalized over the life course and shape people's perceptions and attitudes towards their experience of ageing. These stereotypes are eventually taken over from the surrounding environment by younger people and become self-definitions and internalized stereotypes as they age. Hence, ageing-related (sometimes ageist) messages may eventually be embodied, affecting health, wellbeing and functioning in later life [58]. Based on a meta-analysis and systematic literature review, it was found that negative stereotypes impair people's performance in a stereotype-consistent manner [59]. As such, it may contribute to older people withdrawing from meaningful social activities and a higher likelihood of feeling lonely.

Since there are many stereotypes of older people and ageing, a longitudinal study was conducted to investigate the relationship between expectations of loneliness in old age and actual self-reported loneliness. The results showed that expectations about loneliness in old age were significantly associated with reported loneliness eight years later [28]. Likewise, another study showed that the positive expectations about ageing were associated with new friendships two years later, including close friendships [60]. In this respect, the stereotypes of ageing at the individual level potentially are associated with the degrees of loneliness in older age.

Both self-perceptions of ageing and the experience of loneliness seem to be cross-culturally differentiated. This present study focuses on a sample of community-dwelling older people in Germany and investigates the potential association between self-perceptions of ageing and the reported loneliness among older people. It may contribute to our understanding of this underexplored domain and provide practical measures to prevent or tackle loneliness among older people.

We expect that older people's positive self-perceptions of ageing are related to lower degrees of loneliness. Therefore, we propose Hypothesis 2:

H2: Positive self-perceptions of ageing are associated with lower reported levels of loneliness in older adults.

### **2.3 Self-perceptions of ageing as a possible moderator in the relationship between older people's Internet use and loneliness**

Self-perceptions of ageing may serve as a potential moderator in the relationship between Internet use and the degrees of loneliness in later life. Following the reasoning of the Stereotype Embodiment Theory, individuals perceiving their ageing more positively are more likely to have positive perceptions of being socially connected or feel less lonely. Older people's greater Internet use may effectively decrease the feeling of loneliness, especially if older individuals possess positive self-perceptions of ageing. Considering the role of a moderator affecting the strength of the relation between an independent variable and a dependent variable, the basic moderation effect refers to "an interaction between a focal independent variable and a factor that specifies the appropriate conditions for its operation" [61]. Hence, older people's self-perceptions of ageing are expected to moderate the correlation between Internet use and loneliness in older age. Specifically, we expect that having more positive self-perceptions of ageing strengthens the effect of Internet use on decreasing the feeling of loneliness. Due to data availability, three aspects of self-perceptions of ageing are considered, including personal competence, physical loss and social loss. Therefore, we suggest Hypothesis 3:

H3a: Older people's positive self-perceptions of ageing in personal competence accentuates the effects of digital technology use on the feeling of loneliness.

H3b: Older people's positive self-perceptions of ageing in physical loss accentuates the effects of digital technology use on the feeling of loneliness.

H3c: Older people's positive self-perceptions of ageing in social loss accentuates the effects of digital technology use on the feeling of loneliness.

As the self-perceptions of ageing are potentially transitory, it may accentuate the negative interaction between higher Internet use and loneliness. This paper may contribute to developing interventions to reduce older people's feeling of loneliness in the global context of technological facilitation.

## 3 Method

### 3.1 Respondents

This study utilized the German Ageing Survey (DEAS) [62] conducted by the Research Data Centre of Gerontology (DZA). The Survey is nation-wide and representative cohort-sequential, and it resulted in cross-sectional samples with longitudinal samples of community-dwelling people aged 40 and older. The main goal of the DEAS study is to provide insight into middle-aged and older Germans' living conditions, targeting both individual developments over time and social change [62]. The first sample was randomly drawn in 1996 using a national probability sampling technique and applying stratified sampling by age, gender, and region (East and West Germany). Wave 2 followed in 2002, Wave 3 in 2008, Wave 4 in 2011 (panel survey), Wave 5 in 2014 and Wave 6 in 2017 (n=6626). Additional panel assessments were performed in Waves 2, 3, 5 and 6. Respondents participated in a 90-minute face-to-face interview and filled in a paper-pencil questionnaire, at each measurement point. Before the interview, written informed consent was given by respondents. Please note that an ethical statement was not necessary under the German Research Foundation Guidelines (Deutsche Forschungsgemeinschaft, DFG).

This study derived cross-sectional data from Wave 6 which includes the latest data on older adult's Internet use. In 2017, 5,617 study participants completed the drop-off questionnaire. An online version of the drop-off questionnaire was first introduced in this wave. Among those who filled in the drop-off questionnaire, 1,001 people participated online, and the rest, 4,607 respondents, filled in the paper-pencil version. Those using the online drop-off questionnaire were more likely to be male, younger, healthier, of higher-level education and income, and living in west Germany. As this study focuses on web-use, 4252 (75,8%) stated to have access to Internet, while 1164 (20,8%) had no access. Those respondents without access were significantly older ( $F=13,00$ ;  $p=0,000$ ;  $[-15,47; 14,02]$ ), female ( $\chi^2=81,76$ ,  $df=1$ ,  $p=0,000$ ) and from East Germany ( $\chi^2=100,82$ ,  $df=1$ ,  $p=0,000$ ). Those without Internet access were also more likely to be depressed ( $F=8,04$ ;  $p=0,000$ ;  $[-2,15; 1,21]$ ) functionally impaired ( $F=238,40$ ;  $p=0,000$ ;  $[14,11; 17,82]$ ) and had less positive self-perceptions of ageing ( $F=3,84$ ;  $p=0,000$ ;  $[0,24; 0,30]$ ) but were not significantly more lonely ( $F=3,914067$ ;  $p=0,67$ ;  $[-0,03; 0,05]$ ).

The respondents included in this study are those aged over 65 years old (65 is the retirement age in Germany for people born before 1947), those who participated in the drop-off questionnaire in 2017 and participants who had access to the Internet (n=2119).

### 3.2 Measuring instruments

*Dependent Variable.* The de Jong Gierveld Loneliness Scale [63] is an example of a multidimensional measure of loneliness. A shortened version contains six items was used in the questionnaire to indicate the degrees of loneliness. It was proved that the scale is appropriately regarded as bi-dimensional in samples of older people [64], even

if the instrument can also be used to indicate a single index of loneliness [65]. It is comprised of three negatively formulated items (“I miss emotional security and warmth”, “I miss having people around among which I feel comfortable” and “I often feel rejected”) and three positively formulated items (“There are plenty of people I can rely on when I have problems”, “There are many people I can trust completely” and “There are enough people I feel close to”). It was measured based on a 4-item Likert scale (1 = “strongly agree”, 2 = “agree”, 3 = “disagree” and 4 = “strongly disagree”). The three negatively formulated items were recoded, and the mean calculated using the six items. At least three of the four items must contain valid values to calculate the mean. Hence, a higher value indicates a stronger feeling of loneliness. The internal consistency was proved to be acceptable in our sample, given the reliability coefficient of 0.75 (Cronbach's alpha).

*Independent variable.* Internet use for social contact was assessed by one question in the questionnaire (How often do you use the web for being in contact with friends and relatives e. g. through e-mail, Facebook, chat, video telephony). Respondents ranked the frequency of Internet use on a 6-item Likert scale from “never” to “daily”. The variable was re-coded in a way that higher values represent more frequent Internet use.

As an independent and moderating variable, self-perceptions of ageing (SPA) was assessed using the Age-Cog scales [56, 66, 67]. These subscales capture the individual perception of the ageing-related losses and gains in three aspects. The aspects included in the present study are personal competence (PC), physical loss (PL), and social loss (SL). Each aspect consists of four items. Specifically, PC is measured by four items (“I continue to make plans;” “My capacities are increasing;” “I can still learn new things;” “I can still put my ideas into practice”); PL is measured by four items (“I am less energetic and fit;” “I am less healthy;” “I cannot make up for my physical losses;” “I cannot take as much as before”); SL is measured by four items (“I feel less needed;” “I feel lonely more often;” “I feel less respected;” “I am bored more often”). Respondents rated all items on a four-point Likert scale ranging from (1) strongly agree to (4) strongly disagree. To facilitate the interpretation of the results, the scale PC was re-coded for the analysis. A higher value indicates more positive SPA. The global self-perceptions of ageing score (globSPA) was constructed by aggregating the three perception of ageing subscales and is represented by the mean score. Likewise, a higher value on the aggregated SPA indicates more positive SPA. The internal consistency was proved to be acceptable, given the reliability coefficient of 0.81 (Cronbach's alpha).

*Control variables.* Due to the potential impact of some factors on social interactions, several variables were controlled in the analysis, including age, gender, marital status, physical functioning related to everyday activities [5, 7] and depressive symptoms [5, 68]. The SF-36 subscale was used to measure physical functioning. The degree of physical impairment was assessed by evaluating ten daily activities on a scale from 1 to 3. The sum of the items was eventually transferred into the standard 0-100 range. Higher values indicated a better physical functioning. To capture symptoms of depression the 15-item short form of the German translation of the Centre for Epidemiologic Studies Depression (CES-D) Scale was applied. Higher values indicate higher depressive symptoms.

### 3.3 Statistical analysis

The descriptive statistics and pairwise correlations were computed. In addition, multiple linear regressions were used to model the relation of the outcome variable (loneliness) to Internet use (Hypothesis 1) and self-perceptions of ageing (Hypothesis 2), controlled by potential confounders. In addition, this study tested whether the interaction between Internet use and loneliness varies by degree of SPA (Hypothesis 3). The moderation analysis was performed using a regression-based approach [69].

The model assumptions for linear regressions were checked. In the linear regression models, multicollinearity was tested for by applying the variance inflation criterion. The largest variance inflation factor was 1.5; hence, the absence of multicollinearity was assumed. Further, the White test for heteroscedasticity in the error distribution was performed. Regarding the test statistics (with loneliness as an outcome measure: White's general test statistic = 17,70;  $p < .001$ ), the null hypothesis of homoscedasticity was therefore rejected. Consequently, robust standard errors were used. The normality assumption of the residuals was checked using normal-probability plots, showing that the residuals were approximately normally distributed. The statistical significance was set at  $p < .05$ . All statistical analyses were performed using SPSS 25.0.

## 4 Results

### 4.1 Description of the sample and bivariate correlations

In Wave 6, 3276 participants aged over 65 years (mean age: 74.36 years  $\pm$  6.19 years) replied with either yes or no to the question on Internet access. 47% of those respondents were female and 67.6% were married. The mean score of depressive symptoms in the whole sample was 6.31 ( $\pm$ 5.50; ranging from 0 to 44) and the mean score of physical functioning was 77.89 ( $\pm$ 24.37, ranging from 0 to 100).

All those who reported having access to the Internet ( $n=2119$ ; 64.7% of the whole sample) constituted the final sample used for analysis (see Table 1).

Bivariate analysis (see Table 2) suggested that higher Internet use was negatively correlated with the feeling of loneliness ( $r = -.07$ ,  $p < .01$ ), while more positive self-perceptions of ageing (globSPA) were moderately correlated with a lesser feeling of loneliness ( $r = -.42$ ,  $p < .001$ ). Hence, these findings are in line with our suggested hypothesis 1 and hypothesis 2. In addition, the feeling of loneliness was significantly associated with gender, region, marital status, physical activity and depression.

### 4.2 Moderation analysis

Table 3 shows the result of the moderation analysis. Controlling for potential confounders, the analysis indicated that greater Internet use was associated with a lesser feeling of loneliness ( $\beta = -.02$ ,  $p < .01$ ). Additionally, positive self-perceptions of ageing were significantly associated with lower loneliness scores ( $\beta = -.48$ ,  $p < .001$ ).

**Table 1.** Characteristics (n=2119) of the sample (community-dwelling older adults over 65 with Internet access)

Variables	N (%)	Mean (Std. Deviation)
Age (in years)	/	72.71 (5.67)
Gender		/
Male	1226 (57.9%)	
Female	893 (42.1%)	
Region		/
West Germany	1507 (71.1%)	
East Germany	612 (28.9%)	
Marital status		/
Married, living together	1584 (74.8%)	
not married	535 (25.2%)	
Physical functioning <sup>a</sup>	/	82.20 (21.54)
Depression <sup>b</sup>	/	5.72 (5.19)
Loneliness <sup>c</sup>	/	1.72 (.51)
Internet use <sup>d</sup>		3.97 (1.73)
Daily	475 (22.4%)	
Several times a week	611 (28.8%)	
Once a week	220 (10.4%)	
Once to three times a month	206 (9.7%)	
Less often	348 (16.4%)	
Never	241 (11.4%)	
GlobSPA <sup>e</sup>	/	2.81 (.42)
Personal competence		2.93 (.54)
Social loss		3.24 (.52)
Physical loss		2.27 (.54)

Note. <sup>a</sup> Higher score indicates better physical status. <sup>b</sup> Higher score indicates higher levels of depression. <sup>c</sup> Loneliness was assessed using a short version [70], ranging from 1 to 4 (higher values reflect higher perceived loneliness). <sup>d</sup> Internet use for social contact was assessed through the question ‘How often do you use the web for being in contact with friends and relatives?’ Frequency of use was assessed from 1 to 6 (higher values higher use). <sup>e</sup> The aggregated score of the global self-perceptions of ageing (globSPA) was calculated as the mean score of all three subscales. Higher values indicate more positive SPA; The globSPA consists of three subscales: personal competence, physical loss and social loss.

**Table 2.** Result of Pearson and Chi-square correlation analysis

Variables	Loneliness	Internet use	GlobSPA	Personal competence	Physical loss	Social loss	Age	Gender	Region	Marital status	Depression
Loneliness <sup>a</sup>	1										
Internet use <sup>b</sup>	-.07**	1									
GlobSPA <sup>c</sup>	-.42***	.11***	1								
Personal competence <sup>d</sup>	-.26***	.16***	.79***	1							
Physical loss <sup>e</sup>	-.20***	.08***	.78***	.43***	1						
Social loss <sup>f</sup>	-.51***	.016	.75***	.37***	.39***	1					
Age	.02	-.11***	-.25***	-.24***	-.12***	-.08***	1				
Gender: female <sup>g</sup>	.06*	.01	.01	.01	.02	.00	.06**	1			
Region: east <sup>h</sup>	.10***	-.03	.05*	.04*	.08***	.02	.00	.03	1		
Not married <sup>i</sup>	.09***	.03	.08***	.03*	.02	.14***	.13***	.24***	.01	1	
Depression <sup>j</sup>	.30***	-.05*	-.44***	-.30***	-.36***	-.37***	.11***	.10***	.026	.12***	1
Physical status <sup>k</sup>	-.12***	.079***	.40***	.30***	.43***	.20***	-.25***	-.11***	-.03	-.09***	-.41***

Note: <sup>a</sup> Loneliness was assessed using a short version [70], ranging from 1 to 4 (higher values reflect higher perceived loneliness). <sup>b</sup> Frequency of Internet use was assessed from 1 to 4 (higher values higher use) through the question ‘How often do you use the web for being in contact with friends and relatives?’. <sup>c</sup> The aggregated score of globSPA was calculated as the mean score of all three subscales. Higher values indicate more positive SPA. <sup>d</sup> Personal competence subscale of the Age-Cog scales. <sup>e</sup> Physical loss subscale of the Age-Cog scales. <sup>f</sup> Social loss subscale of the Age-Cog scales. <sup>g</sup> Gender: Ref.: Male. <sup>h</sup> Region: Ref: living in West Germany. <sup>i</sup> Marital status: Ref: married. <sup>j</sup> Higher scores indicate higher levels of depression. <sup>k</sup> Higher scores indicate better physical status. Observations with missing values were dropped for reasons of simplicity (listwise deletion). \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

Moreover, the higher level of loneliness was significantly associated with age (older age), gender (female), marital status (married), severer depression symptoms and lower physical functioning.

Finally, moderated models of regression analyses were used to test the hypothesis that older people's positive self-perceptions of ageing (in personal competence, physical loss and social loss) moderate the correlation between Internet use and the levels of loneliness. Interaction terms (PC x Internet use, PL x Internet use and SL x Internet use) were included in the regression model. The moderation analysis revealed that the correlation between older people's Internet use and their feeling of loneliness was significantly moderated by the AgeCog subscale personal competence (PC). However, the association between Internet use and loneliness in older age was not moderated by the other two subscales of social loss (SL) and physical loss (PL).

## **5 Discussion, conclusion and limitations**

This paper firstly investigated the relationship between older people's Internet use for social contact and their feeling of loneliness. Given that negative stereotypes and expectations of the inevitability of loneliness in later life have been prevalent, we shed light on self-perceptions of ageing among older people. In this respect, this paper zoomed in on three aspects of self-perceptions of ageing (SPA) (i.e., personal competence, social loss and physical loss) that are often connected to the subjective experiences of loneliness. This research therefore investigated whether older people's self-perceptions of ageing accentuate the positive relationship between Internet use and a lower level of loneliness.

The finding supporting Hypothesis 1 suggested that more frequent Internet use (for social interaction with friends and family) was associated with lower levels of loneliness in community-dwelling Germans over 65. This is consistent with prior studies emphasizing the positive impact of older adults' Internet use on various health-related outcomes including loneliness [22]. The association in our analysis was statistically significant ( $P$ -value  $< 0,01$ ), yet, relatively weak. One explanation could be that some older people might not perceive the Internet as a meaningful tool to stay socially connected. Acknowledging the heterogeneity of older adults, some individuals may prefer ways to keep in touch with friends and relatives other than through Internet, without being necessarily lonelier. Future research may also consider applying a life-course perspective for investigating the seemingly bidirectional association between Internet use and self-perceptions of ageing across generations. While among older adults, Internet use appears to be predominantly promoted as a positive medium to decrease loneliness, in younger adults, extensive media use has been widely discussed as a potential cause for loneliness [71]. A life-course perspective may add value to our understanding that Internet use may have significant implications for all populations.

**Table 3.** Result of moderation analysis

Variables	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Age	-.00 (.00)	-.001*** (.18)	-.01** (.00)	-.00* (.00)	-.00* (.00)			
Gender <sup>a</sup>	-.12*** (.02)	-.09*** (.02)	-.11*** (.02)	-.10*** (.02)	-.08*** (.02)			
Region <sup>b</sup>	-.1,5*** (0.2)	-.14*** (.02)	-.14*** (.02)	-.15** (.02)	-.12*** (.02)			
Marital status <sup>c</sup>	.030** (.01)	.030*** (.01)	.03*** (.01)	.03*** (.01)	.01 (.01)			
Depression <sup>d</sup>	.03***(12,07)	.01*** (.00)	.02*** (.00)	.02*** (.00)	.01*** (.00)			
Physical functioning <sup>e</sup>	.00 (-.01)	.00** (.00)	.00 (.00)	.00 (.00)	-.01 (.00)			
Internet use <sup>f</sup>	-.02** (.006)							
GlobSPA <sup>g</sup>		-4.49*** (.03)						
Personal competence <sup>h</sup>			-.21*** (.02)					
Physical loss <sup>i</sup>				-.15*** (.02)				
Social loss <sup>j</sup>					-.46*** (.02)			
PC x Internet use						-.02* (.01)		
PL x Internet use							-.01 (.01)	
SL x Internet use								-.01 (.01)
Adjusted R <sup>2</sup>	.11	.23	.15	.13	.30	.16	.13	.30

Note: <sup>a</sup> 1 Male, 2 Female. <sup>b</sup> 1 Western Germany, 2 Eastern Germany. <sup>c</sup> 1 Married living together, 2 Not married. <sup>d</sup> Higher score indicates a stronger degree of depression. <sup>e</sup> Higher score indicates a better physical status. <sup>f</sup> Have been discriminated against. SWB is the mean of the standardized scores of positive affect and satisfaction with life. <sup>g</sup> The global self-perceptions of ageing score was calculated as the mean score of all three subscales. Higher values indicate more positive SPA. <sup>h</sup> Physical loss subscale of the Age-Cog scales. <sup>i</sup> Physical loss subscale of the Age-Cog scales. <sup>j</sup> Social loss subscale of the Age-Cog scales; observations with missing values were dropped for reasons of simplicity (listwise deletion). \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

In response to Hypothesis 2, this study confirmed that older individuals with positive self-perceptions of ageing reported a lower score of loneliness. Considering the formation of personal perceptions of ageing, negative self-perceptions of ageing may result from the internalization of prevalent ageist messages, according to the Stereotype Embodiment Theory. Negative self-perceptions of ageing and ageism appear to be closely connected [72], while ageism, like other forms of discrimination, can lead to the feeling of loneliness [73]. For example, Sutin et al. [74] investigated the longitudinal relationship between perceived discrimination and subsequent loneliness in a representative sample of older Americans. Over a time period of 5 years everyday perceived discrimination was significantly associated with reports of loneliness. The unique focus on positive self-perceptions of ageing in the present paper may incite future in-depth qualitative studies on investigating the reasons why individuals with positive self-perceptions of ageing prevent or reduce loneliness. This study focused on positive self-perceptions of ageing due to its modifiable nature, which lead to the discussion on the next hypothesis.

The result related to Hypothesis 3 indicated that older people's self-perceptions of ageing (merely in the aspect of personal competence) significantly moderated the relationship between their Internet use and experiences of loneliness. This finding underlines the importance of older people's positive perceptions on their individual competencies in reducing the experience of loneliness. Hence, believing in one's personal competencies regardless of age (e.g., making plans, learning new things, putting ideas into practices) increased the chance to benefit from Internet use and therefore decreased older people's experiences of feeling lonely.

The potential interpretation for the moderating role of SPA (in the aspect of personal competence) could be that Internet users with more positive self-perceptions of ageing are better connected with younger generations, often considered as the more tech-savvy population. A systematic literature review and a meta-analysis launched by the World Health Organization has shown that intergenerational contact has the greatest promise in decreasing negative self-perceptions of ageing and ageism [75]. In this respect, future interventions to prevent and reduce older people's loneliness should consider facilitating intergenerational contact.

Surprisingly, the findings did not support H3b and H3c, since older people's perceptions of ageing-related physical and social losses failed to affect the extent to which Internet use interacts with the feeling of loneliness. A possible explanation might be that some older people have a greater acceptance of ageing-related physical and social loss in later life; therefore, these perceptions would not significantly affect their well-being and behaviors.

In conclusion, this study advanced our knowledge of Internet use in decreasing the feeling of loneliness in later life, as well as self-perceptions of ageing functioning as a moderator in this relationship. Additionally, it provided insights into a practice issue which is how to effectively decrease loneliness in later life. As SPA are modifiable [76], self-perceptions of ageing interventions for older adults might be effective in reducing feelings of loneliness, especially for those less involved in Internet use.

This paper has several limitations to be addressed. First, it acknowledges that there might be relevant covariates neglected in the present analysis. Second, there might be

response bias regarding the Internet use variable, since it is socially expected to use the Internet. Third, the generalization of research findings might be limited for the oldest-old members of society and individuals without access to the Internet.

## 6 Implications for future research

Longitudinal studies can be performed to further investigate the relationship between older people's Internet use and the level of loneliness, and the moderating role of SPA, adjusting for time-constant factors. Additionally, future studies may consider other online activities of older people, given that they are engaged in a diversity of activities that contribute to a lower level of loneliness. Moreover, future research may ensure that the oldest-old members of society are not neglected, considering they are more likely to be living with and affected by loneliness [43]. Future research could also explore the relationship between the level of loneliness and other types of ICT use among older people (e.g., radio, television).

Based on the findings of the present study, it becomes significant to challenge prevalent stereotypes about older people and ageing, especially the stereotypes that conceive older people as an incompetent group. Future intervention studies could provide insights into the role of old age and ageing stereotypes in the context of everyday technology, thus enabling the development of effective methods of improving older people's social participation and wellbeing. In this respect, combatting common ageist assumptions and empowering older people with negative perceptions of ageing may further promote equal access to the benefits Internet technologies promise.

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