

This is an Open Access document downloaded from ORCA, Cardiff University's institutional repository: <https://orca.cardiff.ac.uk/id/eprint/176496/>

This is the author's version of a work that was submitted to / accepted for publication.

Citation for final published version:

Loos, Eugène, Fernández-Ardèvo, Mireia, Peine, Alexander, Rosales, Andrea, Beneito-Montagut, Roser and Blanchet, Daniel 2025. Making sense of older adults' everyday life smartphone use for social connectedness. *Journal of Global Ageing* 2 (1) , pp. 138-158. 10.1332/29767202Y2025D000000021

Publishers page: <https://doi.org/10.1332/29767202Y2025D000000021>

Please note:

Changes made as a result of publishing processes such as copy-editing, formatting and page numbers may not be reflected in this version. For the definitive version of this publication, please refer to the published source. You are advised to consult the publisher's version if you wish to cite this paper.

This version is being made available in accordance with publisher policies. See <http://orca.cf.ac.uk/policies.html> for usage policies. Copyright and moral rights for publications made available in ORCA are retained by the copyright holders.



Journal of Global Ageing

Making Sense of Older Adults' Everyday Life Smartphone Use for Social Connectedness

--Manuscript Draft--

Manuscript Number:	JGA-D-24-00026R2
Article Type:	Research Article
Full Title:	Making Sense of Older Adults' Everyday Life Smartphone Use for Social Connectedness
First Author:	Eugène Loos
Corresponding Author:	Eugène Loos Utrecht University: Universiteit Utrecht Utrecht, NETHERLANDS
Corresponding Author Secondary Information:	
Corresponding Author E-Mail:	e.f.loos@uu.nl
Other Authors:	Mireia Fernández-Ardèvol Alexander Peine Andrea Rosales Roser Beneito-Montagut Daniel Blanche-T.
Abstract:	One of the main uses of smartphones is to be socially connected, and in this sense, older people are not different. Today, there is a growing number of older adults who lack meaningful social connections. Though the smartphone increasingly permeates older adults' everyday lives, little is known about how smartphone usage shapes a sense of social connectedness in their everyday life. To fill this gap, we analyzed the relationship between smartphone use and perceived social connectedness in Canada, the Netherlands, Spain, and Sweden, focussing on the following research question: What is the role of the smartphone in social connectedness in later life? Data collection followed a multi-method approach consisting of smartphone use tracking and an online survey with participants 55 to 79 years old. We used the notion of Social Connectedness, comprising three dimensions: Community Connections, Social Engagement and Personal Relationships. We found that the reported smartphone uses are better predictors of social connectedness than equivalent tracked smartphone usage. Using the smartphone for co-caring purposes intensified feelings of overall social connectedness, while sharing multimedia content enhanced the social connectedness dimensions of Community Connections and Social Engagement. We concluded with limitations and implications for future research. In sum, the obtained results help overcoming stereotypical and ageist assumptions on the older adult's digital practices by providing nuanced and rich evidence on the meanings of smartphone-based communication in a sample of individuals aged 55 to 79 years old.
Keywords:	Older people; smartphone usage; reported usage; tracked usage; social connectedness
Additional Information:	
Question	Response
Conflicts of Interest Please declare any possible conflicts of interest, or state 'The Author(s) declare(s) that there is no conflict of interest' if there are none. Further information about	The Authors declare that there is no conflict of interest.

conflicts of interest can be found in the Bristol University Press Ethical Guidelines.	
Word Count The following word limits apply. The word count excludes the reference list but includes tables, figures, notes etc.: • Research Article (5000-8000 words) • Review Article (5000-8000 words) • Debates (2000-5000 words) • Brief Report (up to 2000 words)	7477
Special issue Is this a submission for a special issue? If so please give details of the special issue, including the Editor if known.	
Research ethics statement Please provide a brief discussion of the ethical issues relevant to your paper and advise if any clearance was granted by your institution or an external ethics committee. We recognise that not all institutions provide or require formal ethics approval processes – please specify whether this applies in your case. For more information on ethical research practices please see the BSG Guidelines on Ethical Research If your paper is accepted, this statement will be included in your published paper.	Ethic approval by the participating universities from the four countries for anonymized data collection and analysis (questionnaires, interviews and tracking).
Data availability statement Please use/complete the most appropriate statement: • Data and materials are located at [insert Public Repository URL] • Pending acceptance, data and materials will be archived at [insert repository] • Data and materials cannot be provided because... • This manuscript does not report on data If your paper is accepted, this statement will be included in your published paper.	Data cannot be provided because the tracked data could not be made public to grant anonymity (see also research ethics statement).
Artificial Intelligence (AI)	I have not used AI tools to prepare my submission

The use of AI tools must be explicitly declared and detailed when submitting a manuscript. We do not recognise AI as meeting the conditions of authorship, and authors are expected to bear full responsibility for ensuring the originality and accuracy of their work. For more information, see our Ethical Guidelines. Please use the tick boxes to indicate if you have used AI tools in writing your manuscript, creating figures or tables, or in the collection and analysis of data.		
Funding Information:	Joint Programming Initiative More Years, Better Lives (643850)	Dr. Eugène Loos
Manuscript Classifications:	Digitalisation; Lived and everyday experiences of ageing; Education; Technology, data and society	
Author Comments:		
Response to Reviewers:	We de-anonymised the paper and revised the paper following the last reviewer's suggestions.	

Title:

Making Sense of Older Adults' Everyday Life Smartphone Use for Social Connectedness

Authors:

Eugène Loos

Utrecht University

The Netherlands

e.f.loos@uu.nl

Mireia Fernández-Ardèvol

Universitat Oberta de Catalunya (UOC)

Spain

mfernandezar@uoc.edu

Alexander Peine

Open Universiteit

The Netherlands

a.peine@ou.nl

Andrea Rosales

Universitat Oberta de Catalunya (UOC)

Spain

arosalescl@uoc.edu

Roser Beneito-Montagut

Cardiff University

UK

Beneito-MontagutR@cardiff.ac.uk

Daniel Blanche-T.

Universitat Oberta de Catalunya (UOC)

Spain

dblanchet@uoc.edu

Abstract:

One of the main uses of smartphones is to be socially connected, and in this sense, older people are not different. Today, there is a growing number of older adults who lack meaningful social connections. Though the smartphone increasingly permeates older adults' everyday lives, little is known about how smartphone usage shapes a sense of social connectedness in their everyday life. To fill this gap, we analyzed the relationship between smartphone use and perceived social connectedness in Canada, the Netherlands, Spain, and Sweden, focussing on the following research question: *What is the role of the smartphone in social connectedness in later life?* Data collection followed a multi-method approach consisting of smartphone use tracking and an online survey with participants 55 to 79 years old. We used the notion of Social Connectedness, comprising three dimensions: Community Connections, Social Engagement and Personal Relationships. We found that the reported smartphone uses are better predictors of social connectedness than equivalent tracked smartphone usage. Using the smartphone for co-caring purposes intensified feelings of overall social connectedness, while sharing multimedia content enhanced the social connectedness dimensions of Community Connections and Social Engagement. We concluded with limitations and implications for future research. In sum, the obtained results help overcoming stereotypical and ageist assumptions on the older adult's digital practices by providing nuanced and rich evidence on the meanings of smartphone-based communication in a sample of individuals aged 55 to 79 years old.

Keywords:

older people

smartphone usage

reported usage

tracked usage

social connectedness

Making sense of older adults' everyday life smartphone use for social connectedness

Introduction

Digitalization has become an inherent part of (later) life, but we are only beginning to understand what this means for the experience of ageing. We consider technology not as a fix to and an intervention into the lives of older adults, but as constitutive for the modes and practices of ageing and later life itself.

In this regard, there is still a research gap regarding the interpretation and analysis of the significance of smartphone use by older adults that goes beyond adoption or health perspectives. In addition to showing that older adults are users of smartphones and other digital technologies, it is important to pose relevant questions regarding what these technologies mean in the lives of older adults, and how they feed into the ongoing re-configuration of later life in the digitized world. Peine and Neven (2019, 2021) talk about the co-constitution of ageing and technology. Such a perspective challenges the traditional interventionist logic, where ageing and later life are researched and articulated as targets for technological interventions. Instead, it is important to consider that (digital) technology is part of the lived realities of many older adults.

Our point of departure, therefore, is an analysis of older adults' everyday smartphone use, and the relevance of these practices to connect with personal networks (such as relatives, friends and peers), community networks and the society as a whole for which we use the notion of social connectedness.

This perspective enables us to contextualize the data we analyse to understand how the experience of being connected is enacted and performed through the use of the smartphone, a pervasive technological device in the everyday life of not only younger but also older adults (e.g., Vincent and Haddon, 2018). As we lack insight into the characteristics and dynamics of actual older adults' everyday use of smartphones and its impact on their social connectedness, we have focused on the subjective experience of being connected as an essential ingredient supporting continued wellbeing in later life (Beneito-Montagut and Begueria, 2021). While it is commonly accepted that mobile communication favours social connectedness and staying connected has become a social norm (Bayer et al., 2016), some older individuals might consider it lower-quality communication in comparison to other media and face-to-face communication (e.g., Godman-Deane et al., 2016; Grünjes et al., 2024).

Our guiding research question is: *What is the role of the smartphone in social connectedness in later life?* To

answer it, we obtained data from 430 older adults between the ages of 55 and 79 living in Canada, the Netherlands, Spain and Sweden (Fernández-Ardèvol et al., 2019, Rosales and Fernández-Ardèvol, 2019). We mapped and traced the use of their participants' smartphones in a comparative perspective, using a multi-method approach that combined tracked data with reported data from an online survey (see Appendix). We analysed these data using theoretical insights from the emerging body of critical studies on ageing and digital technology (Cornwell et al., 2008; Morgan et al., 2019; Waycott et al., 2019). This enables us to gain a richer picture of the meanings of the smartphone in later life, specifically the relationship between different dimensions of perceived social connectedness and smartphone usage.

Social connectedness in later life

The theoretical understanding of social connectedness in later life has evolved significantly, yielding increasingly nuanced perspectives on aging and social engagement. Early theoretical frameworks such as Disengagement Theory (Cumming and Henry, 1961) suggested that aging naturally implies social withdrawal, while Activity Theory (Havighurst, 1961) argued that successful aging requires engagement in activities and relationships. These theories have been criticized for being deterministic. Another concept that has arisen with research on social activity and connectedness is social capital (Putnam, 2000). It includes not just interpersonal connections, but their broader impacts across physical health, mental wellbeing, cognitive resilience, and an individual's capacity to navigate life's complex social environments. These theoretical perspectives are pervasive in literature about technology and later life. Contemporary approaches, exemplified by Intersectionality Theory (Crenshaw, 1989) and socio-constructivist approaches (e.g. Katz, 2013; Gilleard and Higgs, 2014) have broadened this understanding by examining how intersecting social categories shape connection and engagement experiences in a particular social cultural context. The intersection of technology and social connectedness takes on additional complexity when viewed through ageing (Beneito-Montagut et al., 2018; Mort and Roberts, 2019; Peine and Neven, 2019, 2021).

The ubiquity of smartphones across generations, and their role in older adults' social lives, reveal distinct patterns of use and meaning-making that challenge simplified assumptions about technology use and social engagement (Beneito-Montagut et al., 2022). While research soundly agrees that social connectedness is crucial for wellbeing

and health among older populations (Suragam et al., 2021), scholarly attention to older adults' technology-mediated social connections emerged relatively late. This delay is largely rooted in persistent ageist assumptions depicting older adults as disinterested in digital technologies (e.g., Mannheim et al., 2023) making them an ideal target group to be intervened with technologies to reduce their low digital engagements, and in turn, bringing to them additional possibilities to be connected. However, studies have predominantly focused on interpersonal aspects of connection through deficit models, primarily addressing problems like unwanted loneliness and isolation (Silva et al., 2020; Ibarra et al., 2020), poor health (Cotten et al., 2014) or lack of mobility (e.g., Cotten, 2017; Fang et al., 2018, Hunsaker and Hargittai, 2018). Consequently, research has generally been conducted under determinist, interventionist or techno-optimist logics (O'Rourke et al., 2018).

Additionally, the theoretical and conceptual tools generally used in the studies of social connectedness in later life often exhibit two major shortcomings. Firstly, older adults are frequently treated as a uniform group and research tends to apply a unidimensional notion of social connectedness based on interpersonal relationships, while it consists of multiple realities (Victor et al., 2009). Secondly, technologies are often used as straightforward fixes for assumed social deficits or to promote active lifestyles, without accounting for diverse connection experiences.

Indeed, the concept of social connectedness represents a paradigm shift away from deficit-oriented models of ageing. Unlike traditional approaches that frame older adults through the lens of loss and isolation, this approach foregrounds individual agency, highlighting older adults' adaptive capacities and strategies for maintaining social engagement despite changing life circumstances (Cornwell et al., 2008). This nuanced theoretical framework also acknowledges the multi-faceted nature of social connectedness, recognizes the diversity of older adults' experiences and conceptualizes social connection as a complex phenomenon shaped by individual preferences, cultural backgrounds and life circumstances (Ivan and Fernández-Ardèvol, 2017; Morgan et al., 2019; Waycott et al., 2019).

Given the mixed results regarding the effects of mediated technologies on social connectedness in older adults (Beneito-Montagut et al., 2018), research applying this paradigm is necessary to account for the diversity of experiences of social connectedness and technologies in later life and shed new light. Hence, this research applies a multidimensional conceptualization of social connection to overcome the limits discussed above. Here, we

develop a Social Connectedness (SC) index, which is compounded by *Personal Relationships (PR)*, *Community Connections (CC)* and *Social Engagement (SE)*, following Waycott et al. (2019) model (the index is further developed in the Variables in the models' section, p. 8).

Applying this conceptualization of social connectedness, our study recognizes and deals with the complex nature of social connectedness and the potential multiple meanings of being connected. It looks at the experience of being connected as contingent on context and co-shaped by technology. Different social connectedness outcomes may be possible through different uses of diverse smartphones' affordances. For instance, overall social connectedness may vary when using a smartphone for *personal relationships*, to keep in touch with family friends or relatives using an application like WhatsApp; or to sustain *community connections* by being part of a local community, via a Facebook group page; or to *engage with society* by receiving news alerts about current affairs via news apps.

Digital (mobile) practices in later life and the relevance of co-caring

Analyses on mobile communication technologies often converge in assigning a leading role to the younger generations regarding the adoption and diffusion of these technologies (e.g., Castells et al., 2007; Taipale, et al., 2018). However, the popularity of mobile communication among the older population has seen steady growth in recent years. Smartphones have rapidly become the most used device to access the internet among EU seniors (Eurostat, 2020a). In Sweden, the Netherlands, and Spain – in that order – there is a sustained higher internet access rate via a mobile phone compared to the EU average (Eurostat, 2020b). Also, in Canada, older adults have progressively increased their internet adoption to the point where some use smartphones to an extent that is usually ascribed to the young (Statistics Canada, 2018, 2019).

In addition, there is a substantial body of empirical studies showing the various ways in which mobile communication technologies are used in later life and in negotiating connection with the world (Ivan and Hebblethwaite, 2016; Ivan and Fernández-Ardèvol, 2017). In the process of technological domestication (Haddon, 2003, 2007; Silverstone et al., 1992), older adults make deliberate decisions on selecting devices to communicate according to diverse personal circumstances and interests (e.g., Caliandro et al, 2021). They combine smartphones with landline phones (Fortunati, 2018), tablets and computers. A media ecology approach

offers a better way to understand the constellation of communication devices available in their milieus (Sawchuk and Crow, 2010).

The degree of attachment to the mobile device varies at an individual level. Older adults report occasionally being oblivious of the device and sometimes forgetting it at home. While not all users feel compelled to return to retrieve it, for some, this is reason enough to turn back, especially if they are the caregiver of a family member who is left alone in the home (Hardill and Olphert, 2012; Ivan and Fernández-Ardèvol, 2017). Among older users, ensuring the device is always at hand appears to be related to a desire to be available to communicate with those they care about (Ganito, 2018). Reachability and permanent contact with their close personal network are frequently reported drivers for older adults to adopt mobile technology since the initial stages of the research in the area (e.g., Oksman, 2006), a phenomenon also described for the general population (e.g., Katz and Aakhus, 2002). In this context, the idea of the mobile phone as a lifeline should be recalled (Castells et al., 2007). The lifeline can be viewed as a form of caring, an aspect usually analysed in the light of digitalisation and later life (Pein and Neven, 2021) and works in two directions. On the one hand, the smartphone provides access to the support network, that is, when the individual needs to *receive* any form of care (services and products) in the public or private sphere (e.g., Müller, 2019). On the other hand, it also serves as a permanent connection for family or friends *offering* care to each other – which includes the older adult providing and offering such care. The mobile phone, therefore, can be considered a tool for co-caring (e.g., Baldassar, 2016, Rodman, 2013) as it supports a two-direction lifeline that operates in a mundane way (Peine and Neven, 2021; Brownlie and Spandler, 2018). The concept moves beyond the boundaries of health studies, as co-caring refers to everyday life relationships where even checking on someone is part of the co-caring dynamics.

Smartphones provide older users with a sense of emotional companionship and social engagement (Rosales, and Fernández-Ardèvol, 2016; Vincent, 2018) while also allowing more instrumental uses to organize everyday life (Seifert, and Schelling, 2015). Older smartphone users actively access the internet for everyday tasks such as reading or sending emails, searching for information, looking up public transportation schedules, or reading newspapers (Fernández-Ardèvol, 2013; Seifert and Schelling, 2015), whether at home or on the go. Finally, the literature suggests a broad heterogeneity of users (and uses) among older adults in terms of age group, gender, educational level, occupation, urban or rural setting, or cultural context, among other attributes (Fernández-

Ardèvol and Arroyo Prieto, 2012; Hardill and Olphert, 2012; Seifert and Schelling, 2015). Hence, the diversity of older smartphone users merits greater attention to better account for the usage and attributed meaning of such a device in later life.

Smartphone tracking studies in later life

A way of approaching mobile practices and usages is collecting data directly by tracking the activity on the devices, as with the emergence of the smartphone came the possibility of a market for third-party applications that diversify the use of mobile phones. While these devices have given rise to a flourishing and mostly covert economy of collecting and trading in behavioural data (Zuboff, 2019), they also offer the opportunity to collect such behavioural data in a more ethically benign and transparent forms for research purposes. Such purposes include what we call tracking studies, in which all smartphone activities (or logs) are collected to better understand smartphone usage.

Considering the dataset characteristics, such studies can follow two different approaches. They either use data sets from thousands of users of specific services, and analyse it for a purpose that is different from the main purpose of the service, and often without demographic information (e.g., Wagner et al., 2013), or data sets that include demographic information. (e.g., Lee, 2014). In this paper, we took the latter approach, we collected data from 430 participants by a commercial panel explicitly purposed to analyse user behaviour, and provided their demographic information for this aim. Some tracking studies aim at describing general smartphone use, e.g., the frequency, schedule or length of interactions, the amount of data exchanged, and the device location (Hintze et al., 2017; de Nadai et al., 2019). Others focus on understanding the users' behaviour diversity by assessing the wide range of average interactions (Falaki and Estrin, 2010; Bhih et al., 2016) or the different profiles of users depending on their interactions (Zhao et. al., 2016).

Among the latter, a set of analyses considers older adults to understand how age relates to different smartphone use. For instance, Caliendo et al. (2021) applied a mixed-method approach in Italy to analyse the logs of 20 volunteers aged 62 to 76 and explore with them the meaning and relevance of their usages for socializing with their peers and relatives using interviews and group conversations. Besides, de Nadai et al. (2019) relied on a sample of 400.000 users -aged 18 to 68- from an unspecified European country and contextualized the logs with basic sociodemographic data. Finally, Rosales and Fernández-Ardèvol (2019) analysed the evolution

of smartphone usage over time by combining three separate studies conducted in Spain, namely tracked data from a sample of individuals aged 20 and over, an online survey targeting older adults that collected information from individuals aged 60 to 87. However, most studies rely on voluntary sampling processes that tend to exclude individuals beyond a certain age. It is the case of de Nadai et al. (2019), as well as of (Rivron et al. (2016), who conducted their research in France with a young sample of participants aged 17 and over, of whom 12% were 36 and over. Regarding intergenerational comparison, de Nadai et al. (2019) showed that the older the individual, the more limited the number of applications regularly used although noted that their sample only included people up to 68. Rosales and Fernández-Ardèvol (2019) confirmed that older adults use smartphones less often and for less diverse purposes than younger people, and that this difference increases over time. Nevertheless, such a decrease did not necessarily mean a dismissal of the relevance of smartphones among older adults. Interestingly, by combining tracked data with reported data, these studies allowed a non-interventionist understanding of the relevance of the smartphone beyond the frequency of usage.

Methods

We designed a multi-method approach (Cresswell, 2003; Revilla, 2012) combining collected or observed (tracked) data and reported (survey) data on smartphone usage to gain a deeper understanding of the digital practices of older adults and how these relate to their perceived social connectedness. Whereas observed or collected data has been assumed to be more objective, it lacks the richness and subjectivity of self-reported data. Conversely, reported data has been criticized for being unreliable, but this research aims to catch the relevance individuals give to the smartphone to complement observed data.

As with most online methods, our sample is subject to biases (Dutwin, 2023; Maslovskaya, 2022), which primarily stem from the digital divides shaping later life (Seifert, 2020) that usually lead to samples that are younger, more masculinized, and more educated compared to the general older population. Nonetheless, these samples are commonly used and are considered a valuable tool (Räsänen, 2024) capable of yielding results that are analytically significant and insightful when interpreted within the context of their specific characteristics.

The targeted population consisted of internet users between the ages of 55 and 79. For this age range, it was possible to select enough participants in later life having and being active using a smart phone, although whether the younger cohorts should be considered older adults is questionable. However, by including younger older

adults in future studies, it will be possible to understand the transition towards retirement and becoming older adults. The upper age limit (in this case 79 years old) has to do with technical limitations, as the companies managing the online panels did not expect to be able to reach older old individuals. The original sample, with 512 invited participants, resembled the distribution of the online population aged 55 to 79 (broken down by age and gender). On the one hand, the age range allowed older adults (still) active in the labour market to participants who reached the age cut-off defined by the data providers, thus capturing the diversity in the older adult population. On the other hand, the selected countries (Canada, the Netherlands, Spain and Sweden) can be considered as a variety of countries (Anglo-Saxon, Northwest European, Southern European and Scandinavian) whom we accessed through local market study companies provided diversity in terms of digitalisation and smartphone usage in later life (International Telecommunication Union, 2020). This allows us to analyze eventual similarities and differences.

All the interactions with participants were held in the main language of the country. Ethical approval was obtained in the four countries and all the data were anonymized. To reach heterogeneous participants with the same data collection tools, we relied upon a market research company specialized in the two data collection methods that coordinated local partners. All participants received economic incentives for the time and data they contributed to the project. The data collection period extended from February to July 2019 because the fieldwork deployment in each country followed different schedules.

The final sample (tracking and survey data) includes 430 older adults who agreed to have their smartphone activity tracked for 28 days, providing 1.3 million valid logs corresponding to almost 3,800 different apps. The market study company, installed an app in the smartphones of the participants of the study. The app register every time an app is open and displayed in the screen of the smartphone and for how long and it is used as an indicator of user activity on the smartphone. Furthermore, we categorised most of these apps according to their main purpose, based on their name and description as in similar studies (Caliandro et al., 2021; de Nadai et al., 2019; Rosales and Fernández-Ardèvol, 2016). We categorised the apps that covered most of the sample and avoided a long tail to rationalise the categorisation effort by categorizing at least 80% of the total number of logs.

Then, we used for the analysis the categories that were related to social connectedness, as we explain later in the construction of variables. Tracked data were summarized at an individual level to obtain detailed

information on the different categories of apps accessed by each individual during the observed period. At the end of it, all participants completed an online survey on perceived social connectedness and digital practices lasting an average of 12 minutes.

The sample had an average age of 64.1 years ($SD = 1.10$), with a median age of 62.8 years. Male participants comprised a majority at 60.5%, compared to 39.5% for females. Just over half of the participants (54.1%) reported having post-secondary or tertiary education, while 38.4% indicated they were actively engaged in the labor market. The country distribution in descending order was as follows: 27.7% Canada, 29.1% Spain, 22.1% Sweden and 21.2% the Netherlands. When compared to the demographics of each country, we confirmed (Dutwin, 2023; Maslovskaya, 2022) that is a younger, masculinised and better educated sample than the average population. As the sample is quite homogeneous, the sociodemographic variables might play a secondary role in the multivariate models.

The analysis relied on a logistic regression approach to test whether tracked and reported digital practices related to the different dimensions of perceived social connectedness. SPSS 24 was used for the calculations. The model is approached as an exploration to answer the guiding research question, for that reason no specific hypotheses are tested.

Variables in the models

We describe the variables in the models by considering their role in the logistic models: endogenous, explanatory or control variables. Tables 1 and 2 (below) gather them, organized in terms of their nature, continuous and discrete variables respectively, for a more simplified delivery of information.

Endogenous variables

The variables to be explained, or endogenous variables, are the three social connectedness indexes, which range from 1 (low) to 7 (high). They are calculated as the average values of their respective aspects (or indicators). Cronbach's alpha values are 0.79 (PR), 0.74 (CC), 0.60 (SE) and 0.85 (SE), meaning that internal consistency of each construct is acceptable or good in all the cases except for SE, where it is questionable. However, we keep all the four variables, as they are theory-based.

First, the *Personal Relationships index (PR)* distinguishes seven aspects collected as seven different indicators:

participating in social activities in the home (1) or outside the home (2); meeting or talking with neighbours (3); having contact with friends or family (4); having somebody with whom to discuss intimate and personal matters (5); being happy with the contact with friends and family (6), and with the people with whom they can discuss intimate and personal matters (7).

Second, the *Community Connections index (CC)* includes four aspects: engaging in volunteering activities – such as associations, non-profit organizations or charities (1); attending events where people gather – such as parties, shows, festivals or community events, social centres or learning activities (2); engaging in other social activities – such as cultural activities, services at a place of worship or political activities (3); and being happy with the social activities in the community engaged in (4).

Third, the *Social Engagement index (SE)* also has four aspects: sharing ideas or information beyond family, friends and immediate networks (1); believing that participants contribute their ideas to society at large by sharing what they think and do either on their digital devices (2) or in non-digital ways – such as volunteering or providing care to grandchildren (3); and considering that the smartphone connects participants to the world (4).

Finally, the *Social Connectedness index (SC)* aggregates the three individual indexes into one, and is calculated as their average. All the indexes rank quite high, as their average value is at least over 4, with **PR** being the highest (5.35).

To use these variables in the logistic model, following a common approach to analyse variables with some skewness, we split them into two groups of similar size. They are the higher connectedness category that gathers individuals with values equal or above the median, and the lower connectedness category that gathers those values below the median.

Explanatory variables

Perception of the smartphone: This variable aims to measure the attachment to the smartphone. Two variables resulting from a principal component analysis (PCA) summarize how respondents perceive in what extent they are attached to the smartphone. The first component enters the model as variable *P1: Essential social device*, the second as *P2: Useful device*.

As shown in Table 3 (below), the first component (or factor) stands out on four aspects: the smartphone “increases the frequency of my communications” (0.795), is the “main communication channel” (0.775), “I always go back to pick the phone up if I leave it at home by mistake” (0,729), and it “makes my communications more effective” (0.722). In contrast, the predominant aspect in the second component is that “the device is only for emergencies” (0.567). The permanent reachability aspect (“I am always expected to respond to calls and messages immediately”) is seen to be relevant in both cases. Although it is comparatively higher in component 1 than in 2 (0.602 and 0.582, respectively), it is the penultimate aspect in terms of magnitude in the first component but the first one in the second. The result points towards a higher level of detachment in the second case, compared to the first.

Therefore, the first component (variable P1) can be interpreted as representing those respondents who consider (perceive) the smartphone an essential device and are comparatively more attached to it (showing higher levels of appropriation). In contrast, the second variable (P2) represents those for whom it useful but not essential, as it is not their main communication device, and they would not go back home to pick up the phone in case they forgot it, but they consider it useful for an emergency, and they recognize the social pressure to use it as, it they express they are expected to answer the calls they receive immediately. Finally, a relevant aspect throughout is that the smartphone is associated with the “obligation” of always being reachable,.

Ecology of media: The variable *EM: Digital devices* is constructed as the sum of up to seven devices usually used by the respondents: smartphone, landline phone, desktop, laptop and tablet computer, smart TV – or TV with access to the internet, and smartwatch.

Mobile phone features: We focus on four activities that respondents reported using [RU] related to at least one of the social connectedness indexes. Responses are dummy variables (yes/no). First [variable *RU1*], using images, videos or audios (MMS, WhatsApp, Facebook...), a function mainly related to *PR* and to *CC*. Two variables relate to *CC* and *SE*: [*RU2*] watching TV, videos or listening to audios (YouTube, Radio, Spotify...); and [*RU3*] finding out about current events (newspapers, Twitter, Facebook....). The fourth variable is [*RU4*] “managing safety and emergency-care issues (monitor activity and mobility; alerting and reporting in the event of emergencies, falls ...).” This is mainly related to *PR*, either to provide or to receive care, and *CC* as such services might be provided and managed at a local level.

Smartphone intensity of use: We selected three kind of activities tracked on the mobile phone [TIU] with a

conceptual relationship with the *Social Connectedness indexes*. Variables gather the daily activity, counted as the average number of accesses to each category per day. We looked at three types of mobile applications. First, [TIU1] Calls and messaging refers to instant messaging, email and calls (e.g., WhatsApp, Messenger, SMS, regular voice calls...) and mainly relates to *PR*. Second, [TIU2] SNS includes social networks sites and dating sites (Facebook, etc.) and relates to *CC*. And third, [TIU3] News and Media accounts for digital content consumption (e.g., Netflix) and relates to *SE*.

Finally, **control variables** refer to the socio-demographic characteristics of the respondents. They are *Age*, *Gender*, *Country* of residence, *Educational attainment*, household composition (that is, *Living* alone or with others), and working status (that is, *Working outside the home*, with the “no” option including retirement, housework and unemployment).

Table 1. Variables in the model, by category. Continuous variables (N=430) here

Table 2. Variables in the model, by category. Discrete variables (N=430) here

Table 3. Principal Component Analysis here

Results

To explain the perceived social connectedness, we estimated a set of logistic models where explanatory variables are a combination of observed (tracked) and reported (survey) smartphone data.

Columns in Table 4 gather the logistic models to explain higher connectedness at the aggregated social level (SC) and at each of its three dimensions (PR, CC, SE). All rely on the same set of explanatory variables and have acceptable levels of global goodness of fit (e.g., Hosmer-Lemeshow tests are not statistically significant; classifications are better than a dummy model, with quite balanced predictions). Below, we focus on the sign of the statistically significant parameters of the explanatory variables.

First, in the SC index model, *P1: Essential* has a positive sign, that is negative for *P2: Useful*. *RU4: Caring* has a positive sign, as well while the rest of the reported uses (RU) and the tracked intensity of use (TIU) have no statistically significant parameters. *Age* shows a positive sign, *Country* shows positive differences in Canada (vis-à-vis Spain, the reference category), as does *Living with* more people at home. As for the PR index, *P2: Useful* has a negative sign (while *P1: Essential* has a positive sign but is not statistically significant), and *EM: Devices* and *RU4: Care* have positive parameters. Among the control variables, *Country: Canada* shows a positive difference from Spain. In the CC index, *P1: Essential* and *P2: Useful* have positive and negative signs, respectively, although only at a 10% level. *RU1: Sharing contents* and *RU4: Caring* have a positive sign, while *TIU3: News and Media* has a negative sign. *Age* has a positive sign, whereas *Country: Canada* has a positive sign compared to Spain, as does *Living with* other people at home. Finally, in the SE index model, *P1: Essential* has a positive sign. *P2: Useful* is not statistically significant but maintains its negative sign. *RU1: Sharing contents* and *RU4: Caring* keep their positive sign. Finally, *Age* has a positive sign at a 10% level.

Table 4. Logit models to explain Connectedness indexes: SC (Social Connectedness), PR (Personal Relationships), CC (Community Connections) and SE (Social Engagement) here.

The models confirm that the individual's perception of the role of the smartphone (P) relates to the three dimensions of social connectedness. With nuances depending on the index, social connectedness is higher among those who consider the smartphone to be essential (P1) and lower among those who are detached from it and whose smartphone use is useful (P2). Therefore, we confirm the co-constitution of connectedness and smartphone practices (Bayer et al., 2016). The number of digital devices (EM) –used here as a proxy of the ecology of media– has a positive sign in all the models. However, it is only statistically significant in the PR model, which points towards the higher relevance of multi-channel communication when it comes to feeling connected to the personal network (Sawchuk and Crow, 2010).

Regarding the reported smartphone uses (RU), a function we initially associated with PR, namely, the management of safety and emergency-care issues (RU4), it stands out in all the models. This shows the smartphone's relevance as a tool for co-caring (Baldassar, 2016; Peine and Neven, 2021) among the participants in all the countries. A positive association between sharing multimedia contents (RU1) on the phone and CC and

SE was also found. In contrast, hardly any relationship between the apps' frequency of use – tracked intensity of use (TIU) – and the perception of social connectedness (SC) was shown, which suggests that reported uses would act as better predictors. The exception is the consumption of digital news and media (TIU3), which has a negative parameter in all the models and is only statistically significant in the case of CC. Such results point towards a negative relationship between higher use of the smartphone as a screen for consuming news and perceived social connectedness, particularly at the community level, that needs further exploration.

Three control variables appear to relate to social connectedness (SC). First of all, Age shows a positive relationship with social connectedness in all the cases, although it is not statistically significant in the PR model. Second, the Country of residence has an influence that concentrates on the difference between Canada and Spain, with higher levels of social connectedness in the former, except for SE (same sign, but non-significant parameter). Finally, living with others at home increases CC and SC, while the sign is positive in all the models.

Discussion

What is the role of the smartphone in social connectedness in later life? To answer this question, a distinction must first be made between the explanatory capacity of tracked intensity of use (TIU) and reported uses (RU). First of all, it is interesting to observe that according to the statistical analysis, older adults' tracked usage is not related to the perception of social connectedness (SC), while reported uses (RU) act as better predictors. So, we learned that observed tracking did not help to gain insight into how participants used their smartphone to socially connect to others. More specifically, whereas tracking is not able to 'detect' co-caring practices, these become visible in reported data, particularly because this later indicator was built as "RU4:Co-caring (managing safety and emergency-care issues)", which could be interpreted as either the participant either brings care, receives it or both. Also, the reported data showed that older adults' perceived appropriation of the smartphone relates to the three proposed dimensions of social connectedness (*Personal Relationships, Community Connections* and *Social Engagement*), which are higher when the device is seen as an essential social tool (P1) and lower when the usage is useful (P2) –and therefore, not a social tool. Such a result challenges problem-solving, techno-deterministic approaches that would predict higher levels of social connectedness (SC) associated with a higher tracked intensity of use (TIU). The survey showed that participants were mostly expected to always be able to be

reached on the smartphone, which illustrates the need to distinguish, in analytical terms, between observed intensity of use (TIU) and its relevance in daily life, which is captured by the reported usage.

Regarding reported usages, three main implications arise from the survey. First, co-caring (RU4) is relevant to the three dimensions of social connectedness we analyse. Going beyond *Personal Relationships*, co-caring also favours *Community Connection* and *Social Engagement*. It is possible to speculate that the potential for interpersonal relations could constitute a key driver for smartphone use. Eventually, using the smartphone as a (double-sided) lifeline (Castells et al., 2007, Peine and Neven, 2021) might create a higher sense of social connectedness because of an embedded meaning in such usage that extends beyond the boundaries of the older adults' personal network. Second, a positive relationship was found between sharing multimedia contents (RU1) on the phone and *Community Connections* and *Social Engagement*, although this was not associated with *Personal Relationships* or social connectedness in general. These results suggest that the sharing of content on platforms that allow both one-to-one and one-to-many communication is related to community and society at large, while *Personal Relationships*, which may be assumed to entail stronger ties (Vriens and van Ingen, 2018), are rooted in other elements, such as the one-to-one communication enabled by instant messaging apps or voice calls. Third, age appears to be positively related to social connectedness, particularly to ***Community Connections***, in the older adults' sample under study, which would shatter the stereotypical assumption that social connectedness decreases with age.

Limitations and implications for future research

This study includes online older adults living in Canada, the Netherlands, Spain, and Sweden, a set of countries that represent perspectives of smartphone use and penetration from the global north, e.g., Europe and Canada. As mentioned in the Method section our sample included adults aged 55 to 79 that despite not being representative of the general population, provide a valuable analytical tool (Räsänen, 2024). The sample size (N=430) was too small to analyse differences between the younger and the older age cohorts in the survey. However, it was possible to introduce age as a continuous variable, which provided a relevant nuance to the analysis. The study uses a mixed methods approach that combines tracked data with reported data (from an online survey) to compensate for the biases of each method (Caliandro et al., 2021; Rosales and Fernández-

Ardèvol, 2019). Such an approach provides a more detailed picture of smartphone usage that goes beyond techno-optimistic visions, paving the way for a more accurate interpretation of the meaning of smartphone use for older adults. Future research could aim at understanding the evolution of smartphone use over time among older adults and should not hold fast to the age cut-off of 79 years old. Finally, it would be interesting to involve more countries from other continents.

Conclusion

In this article, we asked what the role of smartphones is for the social connectedness of older people. We found that smartphone use is relevant for social connectedness at all three levels of personal relationships, community connection and social engagement. The tracked amount of smartphone usage is not a predictor of perceived social connectedness, while the subjective reporting of usage is. In this sense, our study has shown an important distinction between smartphone use that is experienced as useful – which does not lead to an improved experience of social connectedness – and smartphone use that is a part of co-caring, which does lead to an improve experience of social connectedness. This distinction, however, is invisible to quantifications of smartphone use patterns, and became visible only by a more nuanced analysis of subjective experience. In sum, therefore, the obtained results help overcoming stereotypical and ageist assumptions on the older adult's digital practices by providing nuanced and rich evidence on the meanings of smartphone-based communication in a sample of individuals aged 55 to 79 years old.

This work was supported by the Joint Programming Initiative “More Years, Better Lives” The Potential and Challenges of Demographic Change: Joint Transnational Call for Proposals 2017 Ageing and place in a digitising world <https://jp-demographic.eu/projects/beconnected-at-home/> under Grant 643850.

The Authors declares that there is **no conflict of interest**.

Research ethics statement: Ethic approval by the participating universities from the four countries for anonymized data collection and analysis (questionnaires, interviews and tracking).

Data availability statement: Data and materials cannot be provided because the tracked data could not be made public to grant anonymity.

Alt text: the manuscript doesn't include any visual content.

References

- Baldassar, L. (2016) Mobilities and Communication Technologies: Transforming Care in Family Life, in M. Kilkey and E. Palenga-Moolenbeck (eds) *Family Live in an Age of Migration and Mobility: Global Perspectives through the Life Course*, Basingstroke: Palgrave Macmillan.
- Bayer, J.B., Campbell, S.W. and Ling, R. (2016) Connection cues: Activating the norms and habits of social connectedness, *Communication Theory*, 26(2): 28-149.
- Beneito-Montagut, R., Cassián N. and Begueria, A. (2018) What do we know about the relationship between Internet mediated interaction and social isolation and loneliness in later life?, *Quality in Ageing and Older Adults*, 19(1): 14–30.
- Beneito-Montagut, R. and Begueria, A. 2021. "Send me a Whatsapp when you arrive home": mediated practices of caring about. In: Peine, A. et al. eds. *Socio-gerontechnology: Interdisciplinary Critical Studies of Ageing and Technology*. Routledge Advances in Sociology Abingdon, UK: Routledge, pp. 119-133.
- Beneito-Montagut, R., Rosales, A. and Fernández-Ardèvol, M. (2022) Emerging digital inequalities: A comparative study of older adults' smartphone use, *Social Media+ Society*, 8(4).
<https://doi.org/10.1177/20563051221138756>
- Bhiih, A.A., Johnson, P. and Randles, M. (2016) Diversity in smartphone usage, in B. Rachev and A. Smrikarov (eds.) *ACM International Conference Proceeding Series*, Vol. 1164, Association for Computing Machinery, pp. 81-88.
- Brownlie, J. and Spandler, H. (2018) Materialities of mundane care and the art of holding one's own, *Sociology of Health and Illness*, 40(2): 256-269.
- Caliandro, A., Garavaglia, E., Sturiale, V. and Di Leva, A. (2021) Older adults and smartphone practices in everyday life: an inquire on digital sociality of italian older users, *The Communication Review*, 24(1): 47-78.
- Castells M, Fernández-Ardèvol M, Linchuan Qiu J and Sey, A (2007) *Mobile Communication and Society: A Global Perspective*, Cambridge, Massachusetts: MIT Press.

- Cresswell, J.W. (2003) *Research design: qualitative and mixed-method approaches*, Thousand Oaks, London, New Delhi: Sage Publications.
- Cornwell, B., Laumann, E.O. and Schumm, L.P. (2008) The social connectedness of older adults: A national profile, *American sociological review*, 73(2): 185-203.
- de Nadai, M., Cardoso, A., Lima, A., Lepri, B. and Olive N (2019) Strategies and limitations in app usage and human mobility, *Scientific Reports*, 9(1): 1-9.
- Dutwin, D. and Buskirk, T.D. (2023) 'A Deeper Dive into the Digital Divide: Reducing Coverage Bias in Internet Surveys', *Social Science Computer Review*, 41(5), pp. 1902–1920.
<https://doi.org/10.1177/08944393221093467>
- Eurostat (2020a) *Individuals: Devices used to access the internet [isoc_ci_dev_i]*. ICT Usage in Households and by Individuals (isoc_i).
- Eurostat (2020b) *Individuals: Mobile internet access [isoc_ci_im_i]*. ICT Usage in Households and by Individuals (isoc_i).
- Falaki, H. and Estrin, D. (2010) Diversity in Smartphone Usage. *Proceedings of the International Conference on Mobile Systems, Applications, and Services (MObiSys'10)*.
- Fernández-Ardèvol M (2013) Deliberate missed calls: A meaningful communication practice for seniors?, *Mobile Media and Communication*, 1(3): 285–298. <https://doi.org/10.1177/2050157913493624>
- Fernández-Ardèvol M and Arroyo Prieto L (2012) Mobile telephony and older adults: Exploring use and rejection. *Interactions: Studies in Communication and Culture*, 3(1): 9–24. https://doi.org/10.1386/iscc.3.1.9_1
- Fernández-Ardèvol, M., Rosales, A., Loos, E., Peine, A., Beneito-Montagut, R., Blanche, D., ... and Östlund, B. (2019) Methodological strategies to understand smartphone practices for social connectedness in later life. In *Human Aspects of IT for the Aged Population. Social Media, Games and Assistive Environments: 5th International Conference, ITAP 2019, Held as Part of the 21st HCI International Conference, HCII 2019, Orlando, FL, USA, July 26-31, 2019, Proceedings, Part II* 21 (pp. 46-64). Springer International Publishing.

- Fortunati, L. (2018) How young people experience elderly people's use of digital technologies in everyday life, in S. Taipale, T.-A. Wilska and C. Gilleard (eds) *Digital technologies and generational identity: ICT usage across the life course*, Milton Park, Abingdon, Oxfordshire: Routledge, pp. 102-118.
- Friemel, T.N. (2016) The digital divide has grown old: Determinants of a digital divide among seniors, *New Media and Society*, 18(2): 313-331.
- Ganito, C. (2018) Gendering the mobile phone, in S. Taipale, T.-A. Wilska and C. Gilleard (eds) *Digital technologies and generational identity: ICT usage across the life course*, Milton Park, Abingdon, Oxfordshire: Routledge, pp. 87-101.
- Gilleard, C. and Higgs, P. (2008) Internet use and the digital divide in the English longitudinal study of ageing., *European Journal of Ageing*, 5(3): 233-239.
- Goodman-Deane, J., Mieczakowski, A., Johnson, D., Goldhaber, T. and Clarkson, P.J. (2016) The impact of communication technologies on life and relationship satisfaction. *Computers in Human Behavior*, 57, 219-229. <https://doi.org/10.1016/j.chb.2015.11.053>
- Grünjes, C. E., Macdonald, B. and Hülür, G. (2024) The role of social interaction modality for well-being in older adults. *Psychology and Aging*, 39(4), 364-377. <https://doi.org/10.1037/pag0000816>
- Haddon, L. (2003). Domestication and mobile telephony. In J.E. Katz (Ed.) *Machines that become us: The social context of personal communication technology* (pp. 43-55). Transaction
- Haddon, L. (2007) Roger Silverstone's Legacies: Domestication, *New Media and Society*, 9: 16–24.
- Hardill, I. and Olphert, C.W. (2012) Staying connected: Exploring mobile phone use amongst older adults in the UK, *Geoforum*, 43(6): 1306-1312.
- Hintze, D., Hintze, P., Findling, R.D. and Mayrhofer, R. (2017) A Large-Scale, Long-Term Analysis of Mobile Device Usage Characteristics, *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, 1(2): 1-21.

- Hunsaker, A. and Hargittai, E. (2018) A review of internet use among older adults, *New Media and Society*, 20(10): 3937–3954.
- International Telecommunication Union (2020) *ITU World Telecommunication/ICT Indicators Database online*.
- Ivan, L. and Hebblethwaite, S. (2016) Grannies on the net: Grandmothers' experiences of Facebook in family communication. *Romanian Journal of Communication and Public Relations*, 18(1): 11-25.
- Ivan, L. and Fernández-Ardèvol, M. (2017) Older people and the use of ICTs to communicate with children and grandchildren. *Transnational Social Review*, 7(1): 41-55.
<https://doi.org/10.1080/21931674.2016.1277861>
- Katz, J.E. and Aakhus, M. (eds) (2002) *Perpetual contact: Mobile communication, private talk, public performance*. Cambridge: Cambridge University Press.
- König, R., Seifert, A. and Doh, M. (2018) Internet use among older Europeans: An analysis based on SHARE data. *Universal Access in the Information Society*,
- Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukophadhyay, T. and Scherlis, W. (1998) Internet paradox: A social technology that reduces social involvement and psychological well-being?, *American psychologist* 53(9): 1017.
- Kraut R., Kiesler, S., Boneva, B., Cummings, J., Helgeson, V. and Crawford, A. (2002) Internet paradox revisited, *Journal of social issues*, 58(1): 49-74.
- Lee, U., Lee, J., Ko, M., Lee, C. and Kim, Y. (2014) Hooked on smartphones: an exploratory study on smartphone overuse among college students. *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems*, 2327-2336.
- Mannheim, I., Varlamova, M., van Zaalen, Y. and Wouters, E. J. (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>

- Maslovskaya, O. and Lugtig, P. (2022) 'Representativeness in Six Waves of Cross-National Online Survey (CRONOS) Panel', *Journal of the Royal Statistical Society Series A: Statistics in Society*, 185(3), pp. 851–871.
<https://doi.org/10.1111/rssa.12801>
- Morgan, T., Wiles, J., Park, H. J., Moeke-Maxwell, T., Dewes, O., Black, S. ... and Gott, M. (2019) Social connectedness: what matters to older adults?, *Ageing and Society*: 1-19.
- Müller, B. (2019). The careless society - Dependency and care work in capitalist societies, *Frontiers in Sociology*, 3, 44.
- Oksman, V. (2006) Young people and seniors in Finnish "mobile information society.", *Journal of Interactive Media in Education*, 2(2).
- Orton-Johnson, K. and Prior N. (eds) (2013) *Digital sociology: Critical perspectives*. Basingstroke: Palgrave Macmillan.
- O'Rourke, H. M., Collins, L and Sidani, S. (2018) Interventions to address social connectedness and loneliness for older adults: a scoping review, *BMC geriatrics*, 18(1): 1-13.
- Peine A and Neven L (2019) From intervention to co-constitution: New directions in theorizing about aging and technology, *The Gerontologist*, 59 :15–21.
- Peine A. and Neven .L (2021) The co-constitution of ageing and technology – a model and agenda, *Ageing and Society*, 41: 2845–2866.
- Prohaska, T., Burholt, V., Burns, A., Golden, J., Hawkey, L., Lawlor, B., Leavey, G., Lubben, J., O'Sullivan, R., Perissinotto, C. and van Tilburg, T. (2020) Consensus statement: loneliness in older adults, the 21st century social determinant of health?, *BMJ open* 10(8), p.e034967.
- Putnam, R. D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. Touchstone Books/Simon & Schuster. <https://doi.org/10.1145/358916.361990>

- Räsänen, P., Oksanen, A., Lehdonvirta, V. and Blank, G. (2024) 'Social Media, Web, and Panel Surveys', in Brough, P., *Advanced Research Methods for Applied Psychology*. 2nd ed. London: Routledge, pp. 140–152.
<https://doi.org/10.4324/9781003362715-13>
- Revilla, M (2012) Impact of the mode of data collection on the quality of answers to survey questions depending on respondent characteristics, *Bulletin of Sociological Methodology/Bulletin de Méthodologie Sociologique*, 116(1): 44-60.
- Rivron, V., Khan, M. I., Charneau, S. and Chrisment, I. (2016) Exploring smartphone application usage logs with declared sociological information. *Proceedings - 2016 IEEE International Conferences on Big Data and Cloud Computing, BDCloud 2016, Social Computing and Networking, SocialCom 2016 and Sustainable Computing and Communications, SustainCom 2016*.
- Rodman, M.C. (2013) Co-caring in senior cohousing: A Canadian model for social sustainability, *Social Sciences Directory*, 2(4).
- Rosales, A. and Fernández-Ardèvol, M. (2016) Beyond WhatsApp: Older adults and smartphones, *Romanian Journal of Communication and Public Relations* 18(1): 27–47.
<http://www.journalofcommunication.ro/index.php/journalofcommunication/article/view/200>
- Rosales, A and Fernández-Ardèvol M. (2019) Smartphone usage diversity amongst older adults. In Sayago S. ed. *Perspectives on Human Computer Interaction research with older adults*, Cham: Springer.
- Sawchuk, K. and Crow, B. (2010) Into the grey zone: Seniors, cell phones and milieus that matter. In B. Poppinga, C. Magnusson, W. Heuten, D. McGookin, N. Henze, G.B.M. Claase, M. Pielo, H. Eftiring and J. Peters (eds.), *Observing the mobile user experience: Proceedings of the 1st International Workshop. Held in conjunction with NordiCHI, HaptiMap*, pp. 17-32
- Seifert, A. and Schelling, H.R. (2015) Mobile seniors: Mobile use of the Internet using smartphones or tablets by Swiss people over 65 years, *Gerontechnology*, 14(1): 57-62.
- Silva, P., Matos, A.D. and Martinez-Pecino R. (2020) Can the internet reduce the loneliness of 50+ living alone?, *Information, Communication and Society*: 1-17.

- Silverstone, R., Hirsch, E. and Morley D. (1992) Information and Communication Technologies and the Moral Economy of the Household, in R. Silverstone and E. Hirsch (eds) *Consuming Technologies: Media and Information in Domestic Spaces*, Milton Park, Abingdon, Oxfordshire: Routledge, pp. 115-131.
- Statistics Canada (2018) *Table 22-10-0115-01 Smartphone use and smartphone habits by gender and age group*.
- Statistics Canada (2019) Seniors online. In *Stats in Brief (11-627-M2019024)*.
- Suragarn, U., Hain, D. and Pfaff, G. (2021) Approaches to enhance social connection in older adults: An integrative review of literature, *Aging and Health Research*, 1(3), 100029.
- Taipale S., Wilska, T.-A. and Gillard C. (eds) (2018) *Digital technologies and generational identity: ICT usage across the life course*. Milton Park, Abingdon, Oxfordshire: Routledge.
- Vincent, J. (2018) Electronic emotions, age and the life course, in S. Taipale, Wilska, T.-A and C. Gilleard (eds) *Digital technologies and generational identity: ICT usage across the life course*, Milton Park, Abingdon, Oxfordshire: Routledge, pp. 201-216.
- Vincent, J. and Haddon, L. (2018) *Smartphone cultures*. Milton Park, Abingdon, Oxfordshire: Routledge.
- Vriens, E. and van Ingen, E. (2018) Does the rise of the Internet bring erosion of strong ties? Analyses of social media use and changes in core discussion networks, *New media and society*, 20(7): 2432–2449.
- Wagner, D. T., Rice, A. and Beresford, A.R. (2013) Device Analyzer: Understanding smartphone usage. *Proceedings of the Conference on Mobile and Ubiquitous Systems*, 1-12.
- Waycott J., Vetere, F. and Ozanne, E. (2019) Building social connections: a framework for enriching older adults' social connectedness through emerging information and communication technologies, in B. Neves and F. Vetere (eds), *Ageing and Digital Technology: Designing and Evaluating Emerging Technologies for Older Adults*, Springer, pp. 58-74
- Zhao S., Ramos, J., Tao, J., Jiang, Z., Li, S., Wu, Z., Pan, G. and Dey, A. K. (2016) Discovering different kinds of smartphone users through their application usage behaviors. *UbiComp 2016 - Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, 498-509.

Zuboff, S. (2019) *The Age of Surveillance Capitalism - the Fight for the Future at the New Frontier of Power*. Profile

Books.

Appendix: Survey

Thinking about your life in general (Select one option only):							
	Never or almost never			Sometimes			Always or almost always
	1	2	3	4	5	6	7
Q1. I have social activities in the place where I live							
Q2. I have social activities outside the place where I live							
Q3. I meet or talk with my neighbours							
Q4. I engage in volunteering activities (such as in associations, non-profit organizations, charities, etc.)							
Q5. I attend events where people gather (such as parties, shows, festivals or community events; social centres, or learning activities)							
Q6. I engage in other social activities (such as cultural activities, services at a place of worship, or political activities)							
Q7. I have contact with friends or family							
Q8. I have somebody with whom to discuss intimate and personal matters							
Q9. I share ideas or information beyond my family, friends and immediate networks							
Q10. I believe I contribute my ideas to society at large by sharing what I think and do on my digital devices							
Q11. I believe I contribute to society in other non-digital ways (e.g., volunteering, providing care to grandchildren, etc.)							
Q12. I am happy with the contact I have with friends and/or family							
Q13. I am happy with the people with whom I can discuss intimate and personal matters							

Q14. I am happy with the social activities I do							
---	--	--	--	--	--	--	--

Q15. Apart from your current smartphone, I usually use a... (Select as many options as necessary):

Q15.1 Fixed landline telephone	
Q15.2 Desktop computer	
Q15.3 Laptop	
Q15.4 Tablet	
Q15.5 Smart TV or TV with access to internet	
Q15.6 Smartwatch or wristwatch that monitors pulse, steps, or other physical activities (Fitbit, iWatch, ...)	

Q16. I have regularly used the computer, tablet or smartphone for... (Select one option only):

Less than a year	Between 1 and 5 years	More than 5 years but less than 10	10 years or more

Q17. What do you use the smartphone for? (Select as many options as necessary)

Receive, send or forward	
Q17.1 Text messages (SMS, WhatsApp, Messenger, ...)	
Q17.2 Images, videos or audios (MMS, WhatsApp, Facebook, ...)	
Q17.3 Receive and make voice or video calls (Phone, WhatsApp, Facetime, Skype, ...)	
Q17.4 Watching TV, videos or listening to audios (YouTube, Radio, Spotify, ...)	
Q17.5 Find out about current events (newspapers, Twitter, Facebook, ...)	
Q17.6 Looking up for practical information (timetables, maps, ...)	
Q17.7 Checking tutorials (recipes, home improvements, housekeeping, hobbies, ...)	
Q17.8 Shopping (looking for information or paying)	
Q17.9 Gaming (Candy Crush, ...)	
Q17.10 Managing safety and emergency-care issues (monitor activity and mobility; alerting and reporting in the event of emergencies, falls, ...)	

Q18. Usually when I finish using the smartphone... (Select as many options as necessary):

Q18.1 I turn off the screen pressing the on/off button.	
Q18.2 I leave the screen on until it shuts down on its own after a while	

Q19. [If Q18.2 is selected] And to shut down it takes... (Select one option only):

Up to 15 seconds	Up to 30 seconds	Up to 2 minutes	Up to 5 minutes	Up to 10 minutes	More than 10 minutes	I don't know

Q20. Imagine your screensaver shut off your smartphone as it has been a while since you used it for the last time... (Select one option only):

	Always	Sometimes	Never	I don't know
Q20.1 The screen turns on when I have an incoming notification				
Q20.2 I can see part of the content of that notification on the screen				
Q20.3 I choose the notifications I want to see on the screen				

Q21. I feel that using internet on the smartphone... (Select as many options as necessary):

Q21.1 Is useful	
Q21.2 Exposes my privacy	
Q21.3 Drains the battery	
Q21.4 Poses a risk to my health	
Q21.5 None of the above	

Q22. Thinking about the smartphone... (Select one option only):

	Totally disagree				Totally agree
	1	2	3	4	5
Q22.1 It makes my communication more effective					
Q22.2 It increases the frequency of my communications					
Q22.3 It is the main channel for my communications					
Q22.4 If by mistake I leave it at home, I always go back to pick it up					

Q22.5 I am always expected to respond to calls and messages right away					
Q22.6 It connects me to the world					
Q22.7 The device is only for emergencies					
Q22.8 I use it more out of home than at home					

Q23. Thinking about any function and any application that you have installed: 'I use the smartphone...' (Select as many options as necessary)

Q23.1 While commuting by public transportation or by car	
Q23.2 In open spaces (on the street, at the park...)	
Q23.3 In public places (a bar, restaurant, a waiting room, hairdressing saloon ...)	

Q24. About my smartphone... (Select one option only):		
It's only me who uses my smartphone	Occasionally, somebody else uses my smartphone (such as my partner, a relative, a friend, or colleagues at work)	Usually, somebody else uses it (such as my partner, a relative, a friend, or colleagues at work)

Q25. Thinking about the internet connection of my smartphone (Select as many options as necessary):

Q25.1 At home, I mainly use Wi-Fi	
Q25.2 In places that I visit often I use Wi-Fi if it is available (at relatives', friends', my workplace, ...)	
Q25.3 Outside home, I mainly use mobile data	
Q25.4 If available, I use public Wi-Fi	
Q25.5 I don't know how my smartphone connects to the internet	

Q26. I am... (Select one option only)			
Male	Female	Other (please specify)	Prefer not to say

Q27. I am [_____] years old

Q28. Where I live is... (Select one option only):

A big city [local example]	A medium-size city [local example]	A small city, a town or a country village [local example]	A farm or home in the countryside (farmhouse, country house ...)	Prefer not to say
----------------------------	------------------------------------	---	--	-------------------

Q29. My highest educational level / my latest education exam is... (Select one option only):

Primary level or less	Secondary level	Tertiary level up to Bachelor or equivalent	Tertiary level, post-graduate studies	Prefer not to say
-----------------------	-----------------	---	---------------------------------------	-------------------

Q30. Currently, I am ... (Select as many options as necessary):

Q30.1 Full-time worker	
Q30.2 Part-time worker	
Q30.3 Unemployed	
Q30.4 Retired	
Q30.5 Unpaid occupation in the home (such as housework, care work)	
Q30.6 Volunteering or unpaid occupation	
Q30.7 Other	

Q31. Besides me, I live with... (Select one option only):

0 people (I live alone)	1 person (we are 2 at home)	2 people (we are 3 at home)	3 people (we are 4 at home)	4 people or more (we are 5 or more at home)
-------------------------	-----------------------------	-----------------------------	-----------------------------	---

Q32. [If '0 people (I live alone)' is not selected in Q31] I live with... (Select as many options as necessary):

Q32.1 Couple (or partner in life)/Spouse	
Q32.2 Son(s)/Daughter(s)	
Q32.3 Other relative(s)	
Q32.4 Friend(s)	
Q32.5 Other(s)	

Q33. I live in... (Select one option only):

My own house (property or rented house or apartment)	My child's place	A shared house or flat	A retirement home
--	------------------	------------------------	-------------------

Table 1. Variables in the model, by category. Continuous variables (N=430)

Analytical concept	Variable	Mean	Std. Dev.	Mode	Median	Min.	Max.
<i>Connectedness</i> [endogenous variables]	PR: Personal Relationships [1-7]	5,35	1,008	5,43	5,43	2,00	7,00
	CC: Community Connections [1-7]	4,34	1,364	4,00	4,25	1,00	7,00
	SE: Social Engagement [1-7]	4,46	1,186	4,00	4,38	1,25	7,00
	SC: Social Connectedness [1-7]	4,71	0,986	3,61	4,70	1,88	7,00
<i>P: Perception, smartphone</i> [explanatory variables]	P1: Essential social device [PCA factor score FAC1_2]	0,00	1,000	1,70	0,04	-2,82	1,70
	P2: Useful device [PCA factor score FAC2_2]	0,00	1,000	0,72	-0,04	-2,51	4,03
<i>EM: Ecology of media</i> [explanatory variable]	EM: Digital devices [1-7]	4,18	1,312	4,00	4,00	1,00	7,00
<i>TIU: Smartphone, Tracked intensity of use (average number of accesses per day)</i> [explanatory variables]	TIU1: Calls, messages, email (WhatsApp, Messenger, SMS, regular voice calls ...) – Personal	26,46	23,295	7,00	20,08	0,00	180,75
	TIU2: SNS: social network sites (Facebook, Instagram, Tinder ...) – Personal & Community	5,45	11,575	0,00	1,50	0,00	139,26
	TIU3: News & Media: digital content consumption (e.g., Netflix) – Society	1,83	5,031	0,00	0,00	0,00	61,86
<i>Control variable</i>	LN(Age) [original variable: 55-79, expressed in logarithm]	4,16	0,096	4,09	4,14	4,01	4,37

Table 2. Variables in the model, by category. Discrete variables (N=430)

Analytical concept	Variable	%	
RU: Smartphone reported use [explanatory variables]	RU1: Sharing images, videos and audios (MMS, WhatsApp, Facebook, ...) -- Personal & Community	81,6	
	RU2: Watching TV or videos, listening to audios (YouTube, Radio, Spotify ...) - Community & Society	50,0	
	RU3: Find out about current events (newspapers, Twitter, Facebook ...) - Society & Community	72,6	
	RU4: Managing safety and emergency-care issues (monitor activity and mobility; alerting and reporting in the event of emergencies, falls ...) - Personal	31,9	
Control variables	G: Gender	Male	60,5
		Female	39,5
	C: Country	Canada (CA)	27,7
		Spain (ES)	29,1
		Netherlands (NL)	21,2
		Sweden (SW)	22,1
	E: Educational attainment	Up to secondary	44,9
		Post-secondary	42,1
		Tertiary	13,0
	L: Living	Alone	20,7
		With more people	79,3
	W: Working outside home	Yes	38,4
No		61,6	

Table 3. Principal Component Analysis

Thinking about the smartphone...	1	2
It increases the frequency of my communications	,795	-,271
It is the main channel for my communications	,775	,076
If by mistake I leave it at home, I always go back to pick it up	,729	,321
It makes my communication more effective	,722	-,279
I am always expected to respond to calls and messages right away	,602	,582
The device is only for emergencies	-,399	,567

N=430. Extraction method: Principal Component Analysis. 2 components extracted

Table 4. Logit models to explain Connectedness indexes: SC (Social Connectedness), PR (Personal Relationships), CC (Community Connections) and SE (Social Engagement)

N=430	SC Higher=50,2%		PR Higher=48,6%		CC Higher=49,1%		SE Higher=49,8%	
	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)
P1:Essential social device	0,374**	1,453	0,127	1,136	0,228*	1,256	0,715***	2,044
P2:Useful device	-0,224**	0,799	-0,345**	0,708	-0,190*	0,827	-0,006	0,994
EM: Digital devices	0,133	1,142	0,245**	1,278	0,060	1,062	0,120	1,127
RU1:Sharing contents	0,474	1,607	0,165	1,179	0,733**	2,081	0,730**	2,074
RU2:Watching or listening to contents	0,308	1,361	-0,167	0,846	0,196	1,217	0,322	1,380
RU3:News (finding about current events)	0,107	1,113	0,168	1,183	0,136	1,146	0,296	1,345
RU4:Co-caring (managing safety and emergency-care issues)	0,730**	2,074	0,653**	1,922	0,711**	2,036	0,568**	1,765
TIU1: Calls, messages, e-mail	-0,007	0,993	0,000	1,000	0,000	1,000	0,002	1,002
TIU2: SNS	0,014	1,014	0,015	1,015	0,012	1,012	0,018	1,018
TIU3: News & Media	-0,010	0,990	-0,009	0,991	-0,068**	0,934	-0,012	0,988
G: Gender (ref: Male)	0,145	1,156	0,252	1,287	0,206	1,229	0,134	1,144
A: LN(Age)	2,438**	11,453	0,925	2,521	3,948**	51,844	2,46*	11,735
C: Country [ref: SP]								
[CA]	0,741**	2,099	0,503*	1,654	0,905**	2,471	0,282	1,325
[NL]	0,027	1,027	0,364	1,438	-0,278	0,757	0,346	1,413
[SE]	0,049	1,050	0,054	1,055	0,457	1,579	-0,322	0,725
E: Education [ref: Up to secondary]								
[Post-Secondary]	0,009	1,009	-0,081	0,922	0,273	1,314	-0,059	0,943
[Tertiary]	0,288	1,334	-0,102	0,903	0,586	1,798	0,147	1,158
L: Live with (ref: Alone)	0,483*	1,621	0,278	1,320	0,480*	1,616	0,248	1,282
W:Working(ref:No)	-0,073	0,929	-0,019	0,981	-0,078	0,925	0,022	1,023
Constant	-12,075**	0,000	-5,867	0,003	-18,59**	0,000	-12,371**	0,000
Classif Lower/Higher (%) ¹	65,4	68,1	68,8	59,3	66,2	71,1	64,4	70,6
Chi^2 (G)	66,7		64,2		68,6		67,4	
-2lnlikelihood	528,783		551,214		514,283		503,14	
Cox-SnellR ²	0,145		0,098		0,173		0,194	
Nagelkerke,pseudoR ²	0,193		0,131		0,231		0,259	
AIC/BIC	566,783	759,207	589,214	781,638	552,283	744,707	541,140	733,564
Hosmer-Lemeshow Test	1,159	(0,997)	5,568	(0,695)	10,839	(0,211)	3,346	(0,911)

1 The cutting point is set as the % of cases in which the endogenous equals Higher.

Significance:***p=0,000;**p<=0,050;*p<=0,100 ¹Cutpoint:0,50