

The impact of ‘technology generations’ on older adults’ media use: Review of previous empirical research and a seven-country comparison

Loredana Ivan PhD^{a,*}, Eugène Loos PhD^b, Ioana Bird PhD^a

^aNational University of Political Studies and Public Administration, Bucharest, Romania;

^bUtrecht University School of Governance, the Netherlands; *Corresponding author: loredana.ivan@comunicare.ro

Abstract

Background: In our information society, media use plays an important role. However, knowledge is lacking about whether specific birth cohorts show preferences for specific traditional or new media and whether technology generations can be identified across different countries.

Objective: A cross-cultural research project was carried out with the aim of providing empirical evidence for the concept of ‘technology generations’ formulated by Sackmann & Weymann (1994; 2013) in relation to media use by older adults. The research questions focus on empirical evidence for the existence of technology generations related to media use and preferences.

Methods: We tested differences in media use and media preferences (traditional versus new media) in Austria, Canada, Denmark, Israel, the Netherlands, Romania and Spain, using commensurate samples consisting of Internet users aged 60 years and older at the time we started collecting data in 2016 (N=10527). We selected three technology generations: the ‘mechanical generation’ (age group of 78 and above), the ‘household revolution generation’ (age group of 68-77), and the ‘technology spread generation’ (age group of 60-67), and analyzed the differences in media use and preferences between these technology generations and across the seven countries.

Results: Our cross-cultural data reveal differences between the technology generations, especially in terms of media use, but not in technology media preference (time spent using different media). We also found the effect of country of origin to be stronger than the effect of generation in explaining older adults’ preferences for traditional vs new media.

Conclusions: The results point to the need for a more nuanced view of the concept of ‘technology generation’, i.e., one taking into account contextual aspects, such as country of origin, gender, level of education, working status and the interaction effect between country of origin and ‘technology generation’.

Keywords: Technology generation, age, older adults, media use, digital media, technology acceptance, media replacement

INTRODUCTION

Background

In the digitizing, ageing societies of the West, the number of older adults making use of digital media is on the rise. At the same time, these societies are also finding themselves confronted with the specter of so-called digital divides, of which at least three have been distinguished. The first is between those with, and those without, access to digital media; a second digital divide is between those with the skills and those lacking the skills to make use of digital media (Attewell, 2001; Hargittai, 2001); and a third digital divide relates to the “gaps in individuals’ capacity to translate their internet access and use into favorable offline outcomes” (Van Deursen & Helsper, 2015, p. 30). Older adults are amongst those that may be affected by these digital divides, something we

know is a global phenomenon (Norris, 2001). This is due to the fact that older users are often “lag-gards” (Rogers, 2003) when it comes to adopting new (technological) products. Their lack of experience, more than their age, is an important factor that plays a role in this regard (Hill et al. 2011; Loos, 2011; Loos & Romano Bergstrom, 2014).

In many countries, statistics such as those published by Pew Research Center (PEW 2017) in the USA show that in 2017, “roughly two-thirds of those ages 65 and older go online and a record share now own smartphones – although many seniors remain relatively divorced from digital life”. Similarly, EU statistics show that 51% of adults aged 55 and older used the internet at least once a week in 2017 (Standard Eurobarometer, 2017, p. 16). Such statistics provide insight

The impact of 'technology generations' on older adults' media use

Table 1. Technology generations for household appliances in West and East Germany (1992).

Technology generation	Cohort
Mechanical	<1938
Household revolution	1939-1948
Technology spread	1949-1963
Computer	1964-1979

Source: Sackmann & Winkler (2013, p. 497) based on Sackmann & Weymann (1994)

into the percentage of those in these age groups with access to the internet, but say nothing about the correlation between the percentage of older adults who have internet access and the use by this age group of both digital and traditional media, such as printed versions of newspapers, radio and television. Nor do we know whether specific birth cohorts (more information will follow below) show preferences for specific traditional and new media or whether technology generations can be identified across different countries. In this paper we therefore use the concept of technology generations as developed by Sackmann & Weymann (2013, p. 493), who defined these as "groups of birth cohorts whose conjunctive experience with technology is differentiated by social change" to gain more insight into older adults' media use and their preferences.

Technology generations

To what extent can older adults learn to really master new media with which they have not grown up? To answer this question, Van de Goor & Becker (2001) point out how important the formative period in life is:

In most of the publications about the formative period, the apex of that period is situated at about the age of seventeen and its end at about the age of twenty-five. Breitsamer (1976) has tested the hypothesis of the apex at the age of seventeen. The hypothesis was confirmed (conclusions restricted in time and space). To set the limit at the age of twenty-five is based on the idea that young adults at about that age acquire social independence. They have finished their education, have an income of their own and have set up their own household. The age limit of twenty-five is still primarily a component of the standard life course. Empirical testing is restricted to life courses that include marriage and a first child.

Table 2. Technology generations for private use of ICT in Germany (2004 & 2010).

Technology generation	Cohort
Mechanical	<1938
Household revolution	1939-1948
Technology spread	1949-1963
Computer	1964-1979
Internet	1980>

Source: Sackmann & Winkler (2013, p. 497)

The end of the formative period is relatively late if the level of education is relatively high (conclusions restricted in time and space). (p. 136)

A birth cohort – a cohort whose members have all been born within a certain span of time - will experience certain life events in the same way. Obviously, the introduction of a new technology counts as such a life event. Huysmans et al. (2004) argue that "successive cohorts grow up, each with their own specific constellation of available media, media competency and media preferences. These early experiences with media could later lead to shared behavioral patterns." (p. 20) [original in Dutch, translated by the authors of this paper]

Similarly, Van der Goot (2009, p. 255) argues: "(...) generations may very well develop specific patterns of media use when young and remain loyal to these patterns throughout the rest of their lives (Hofmann & Schwender, 200; Mares & Woodard, 2006)", (p. 255) [original in Dutch, translated by the authors of this paper]. Yet even though we belong to a specific cohort, depending on our stage of life, we might still be interested in using a particular medium (see for example Mante-Meijer, & Loos, 2008; Loos & Mante-Meijer, 2009, on the differences and similarities in the use of old and new media by different Dutch age groups looking for health information). We are never too old to learn new skills, such as how to use the new media (Loos, 2010, 2012; Van de Goor & Becker, 2001, p. 137). The question is whether there is empirical evidence in support of the notion that not having experienced the introduction of a new technology during the formative years impacts later media use to a certain extent. Sackmann & Winkler (2013, pp. 493-494) refer to 'technology generations' to explain this phenomenon.

Building on theories of generation (Mannheim, 1997; Ryder, 1965; Becker, 1991) and technology adaptation in everyday life 5-7, the concept of 'technology generations' was developed by German sociologists in the early 1990s (Sackmann & Weymann, 1994; Sackmann, 2013; Weymann & Sackmann, 1993; Sackmann & Winkler, 2013, p. 493) who defined a technology generation as "groups of birth cohorts whose conjunctive experience with technology is differentiated by social change". As Sackmann & Winkler (2013, p. 493) state: "Fast technological change, especially a change of basic technology, enlarges inter-cohort differences and raises the likelihood of a conscious perception and description of differences as generational difference. By their contemporary technological actions, people reproduce or dissolve technology generations technological practice=doing and undoing generation). The likelihood of the adoption of an innovative technological practice in later adult life ('undoing generation') is higher if the expected re-

The impact of ‘technology generations’ on older adults’ media use

Table 3. Differences between the three technology generations regarding background characteristics and countries (Ntotal = 10527).

	Technology spread	Household revolution	Mechanical	Total sample
Country***/ Total	5926 (56.3%)	3831 (36.4%)	770 (7.3%)	10527
Austria	948 (58.3%)	637(39.2%)	42 (2.6%)	1067
Canada	1766(49.9%)	1412(39.9%)	360 (10.2%)	3538
Denmark	312(43.6%)	315(44.1%)	88 (12.3%)	717
Israel	501(62.0%)	258(31.9%)	49(6.1%)	808
The Netherlands	420(52.4%)	309(38.6%)	72(9%)	801
Romania	581(72.6%)	172 (21.5%)	47(5.9%)	800
Spain	1398(62.5%)	728(32.5%)	112(5%)	2238
Gender***				
Women	3064 (51.7%)	1648(43%)	343 (44.4%)	5054
Men	2862(48.3%)	2183 (57%)	428 (55.6%)	5473
Education**				
Up to lower secondary	449 (7.7%)	228 (7.6%)	82 (10%)	819
Upper secondary	2015 (34.6%)	1321 (34.8%)	204 (26.9%)	3540
Higher education	2196 (37.7%)	1370(36.1%)	288(38%)	3854
Full academic	1170(20.1%)	816 (21.5%)	183(24.2)	2169
Income				
Lower than average	876(17.6%)	574(17.7%)	127 (19.7%)	1577
About average	1384 (27.8%)	963 (29.6%)	153 (23.7%)	2500
Higher than average	2726 (54.7%)	1715 (52.7%)	365 (56.6%)	4806
Retirement status***				
Retired	3409 (62.4%)	3454 (92.9%)	721 (96.4%)	7584
Not retired	2051(37.6%)	265 (7.1%)	27 (3.6)	2343

***p < .001; **p < .01

maintaining years of active life increase (for instance, by postponing retirement)."

They add that the “concept of technology generations encompasses technologically related cohort effects (Fozard & Wahl, 2012) - long lasting differences between birth cohorts in a given society- by referring to cohort differentiation due to changes in the social and cultural environment. It adds a generational perspective in sensu Mannheim (1979) by viewing basic technology changes as discontinuous breaks in technological evolution. Changes in basic technology causing generational differentiation usually occur when a new technology reaches a 20% threshold in households in the relevant formative years (ca. 15-25 years) of birth cohorts (Ryder, 1965; Rogers, 2003).”

The original study on technology generations based on qualitative interviews, group discussion, surveys, and secondary data and conducted in western and eastern Germany in the early 1990s by Sackmann & Weymann (1994) provid-

ed empirical evidence for the existence of the following ‘technology generations’ in relation to the use of household appliances (Table 1).

An ICT survey on the private use of information and communication technologies conducted by Sackmann & Winkler (2013) in 2004 and 2010 based on data from the Statistical Bureau of Germany not only found empirical evidence for the same four technology generations, but identified a fifth one as well, characterized by the use of the Internet (Table 2).

RESEARCH AIM AND QUESTIONS

This paper aims to shed the light on studies examining the effect of ‘technology generations’ on media use and the extent to which there is empirical evidence in seven countries for this concept. We aim to answer the following research questions:

RQ1: Are there indeed previous studies providing empirical evidence for the existence of technology generations?

The impact of ‘technology generations’ on older adults’ media use

Table 4. Percentages of traditional media versus new media use among members of the three technology generations (Ntotal =10527).

	Technology spread	Household revolution	Mechanical	Total sample
Traditional media use				
Watch television on a TV set**	5437 (91.7%)	3575 (93.3%)	724(94%)	9736
Listen to radio on a radio set **	3745 (63.2%)	2537 (66.2%)	483 (62.7%)	6767
Read newspapers/magazine in the printed version***	3533 (59.6%)	2513 (65.6%)	558 (72.5%)	6604
Read books in the printed version***	2570 (43.4%)	1888 (49.3%)	386 (50.1%)	4844
New media use				
Watch Television on a computer***	1285 (21.7%)	746 (19.5%)	117 (15.2%)	2148
Watch television on a mobile phone*	520 (8.8%)	290 (7.6%)	48 (6.2%)	858
Listen to radio on a computer***	856 (14.4%)	474 (12.4%)	72 (9.4%)	1402
Listen to radio on a mobile phone***	596 (10.1%)	308 (8.0%)	39 (5.1%)	943
Read newspapers/magazine on the Internet***	3098 (52.3%)	1874 (48.9%)	328 (42.6%)	5300
Read books in the electronic version*	1121 (18.9%)	700 (18.3%)	111 (14.4%)	1932
Old versus new technologies/applications				
Using landline phone***	5926 (79.2%)	3264 (85.2%)	691 (89.7%)	8649
Using mobile phone***	5416 (91.4%)	3483 (90.9%)	658 (85.5%)	9557
Using mobile phone-SMS***	3715 (68.6%)	2343(67.3%)	321 (48.8%)	6379
Using mobile phone-music player***	916 (16.9%)	348 (10.0%)	33(5%)	1297
Using mobile phone-taking photos***	4108 (75.8%)	2447(70.3%)	384(52.9%)	6903
Using mobile- recording videos***	2019 (37.3%)	857 (24.6%)	97(14.7%)	2973
Using mobile-viewing websites***	2731(50.4%)	1231 (35.3%)	129 (19.6%)	4091
Using mobile-instant messaging***	2634(48.6%)	1251(35.9%)	141 (21.4%)	4026
Using mobile-social network sites (SNS)***	2149 (39.7%)	897(25.8%)	100 (15.2%)	3146
Using mobile-games***	1149 (21.2%)	534(15.3%)	55 (8.4%)	1738

***p < .001; **p < .01; *p < .05

Following the age categories indicated by Sackmann & Winkler (2013), we used commensurate samples consisting of Internet users aged 60 years and older at the time we started collecting data in 2016. We selected the ‘mechanical generation’, which referred to those born in 1938 or before and who were therefore aged 78 and over; the ‘household revolution generation’, born 1939-1948 and aged 68-77 in 2016; and the ‘technology spread generation’, consisting of those born between 1949 and 1956 and who were therefore aged from 60 to 67 in 2016). We tested their use of and preferences in traditional media versus that of the new media with the aim of answering the following research questions:
 RQ2a: Does the extent to which traditional media are used differ between the three technology generations?

RQ2b: Does the extent to which new media are used differ between the three technology generations?

The concept of a ‘technology generation’ might be restricted to the national contexts in which it has been tested (see also the review of previous studies in the next section). The next section will show that the empirical studies conducted in this field rarely use cross-cultural data. Our subsequent questions are therefore:

RQ3a: Do older people belonging to different technology generations from different countries have different media preferences?

RQ3b: Is there an interaction effect between country and technology generation on older people’s media use?

The impact of ‘technology generations’ on older adults’ media use

Table 5. Two-way ANOVA assessing the effect of technology generations and country of origin on the importance of traditional media index.

Tests of between-subjects effects						
Dependent Variable: Importance of traditional media Index						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	136037.867 ^a	20	6801.893	8.289	.000	.026
Intercept	2385194.298	1	2385194.298	2906.810	.000	.315
Country	58558.764	6	9759.794	11.894	.000	.011
Generations	3630.178	2	1815.089	2.212	.110	.001
Country * generations	21791.951	12	1815.996	2.213	.009	.004
Error	5176053.495	6308	820.554			
Total	13237494.000	6329				
Corrected Total	5312091.362	6328				

a. R Squared = .026 (Adjusted R Squared = .023)

Our goal is to analyze the media formats (traditional versus new media) used by each of these three technology generations and to establish whether there are differences in preferences (time spent on the two types of media formats). We will first answer RQ1 by making use of a state-of-the-art review of empirical studies which analyzed technology generations. Then, RQ2a/b and RQ3a/b will be addressed by using data from a cross-national study in older adults conducted in Austria, Canada, Denmark, Israel, the Netherlands, Romania and Spain in 2016 and 2017, based on the data set from the ACT project: Older audiences in the digital media environment: A cross-national longitudinal study. Wave 1 Report 1.0 (Loos et al., 2018). More details about the methodology of this study are presented in the Method section.

Review of previous empirical studies in the field

RQ1: Are there indeed previous studies providing empirical evidence for the existence of technology generations?

To answer this first research question, we present a review of the previous empirical studies in this field. A google scholar search (10.02.2019) using the key word ‘technology generation’ returned several hits for scientific publications on this topic that we discuss in this section. Note that we did not include studies on technology generations focusing on different generations of technological products, such as that of Stremersch et al. (2010).

Sackmann et al. (1992a/b) were the first to use the concept of technology generations, in a study based on data collected in Germany in 1992. We found six other studies (see also Table 9, including another empirical study from Sackmann

& Winkler (2013) also conducted in Germany; the empirical studies conducted by Van de Goor & Becker (2001), Docampo Rama et al. (2001) and Docampo Rama (2002) in the Netherlands; the empirical study from Lim (2010) using UK-based data; and the empirical study conducted by Van der Goot et al. (2018) across the six countries of Germany, Spain, UK, USA, France and the Netherlands. The oldest empirical study was conducted in 1992 by Sackmann et al. (1992a/b); the most recent, by Van der Goot et al. (2018), is based on data collected in 2012. The number of participants in the single country studies varied from 1,015 (Docampo Rama et al., 2001 and Docampo Rama, 2002) to 23,000 [Sackmann & Winkler, 2013]. In the cross-national study (Van der Goot et al., 2018), the lowest number of participants from any country was 943 and the highest, 977. Sackmann et al. (1992a/b), Docampo Rama et al. (2002), Sackmann & Winkler (2013) and Van der Goot et al. (2018) used surveys to collect the data; Van de Goor & Becker (2001) conducted a computer assisted face-to-face survey investigating the possession and usage of appliances, which included a 7-item sum scale for attitude towards technology; Docampo Rama et al. (2001) used experiments, while Lim (2010) made use of semi-structured interviews, content analysis, experiments and surveys. All seven studies used the concept of formative years, with Sackmann et al. (1992a/b), Docampo Rama et al. (2001, 2002) and Sackmann & Winkler (2013) identifying the ages of 15 to 25 as the crucial period during which the introduction of a new technology decisively impacts media usage in later years. Lim (2010) extends this to 10-30 years and Van der Goot et al. (2018) fail to specify any age range. Van de Goor & Becker (2001) state: “In social research the formative period is generally defined as the period between 10-25

The impact of ‘technology generations’ on older adults’ media use

Table 6. Two-way ANOVA assessing the effect of technology generations and country of origin on the importance of new media index.

Tests of between-subjects effects						
Dependent Variable: <i>New_media_Index</i>						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	99174.017 ^a	20	4958.701	17.200	.000	.032
Intercept	421728.243	1	421728.243	1462.821	.000	.123
Country	41344.698	6	6890.783	23.902	.000	.014
Generations	311.335	2	155.668	.540	.583	.000
Country * generations	3738.360	12	311.530	1.081	.372	.001
Error	2993397.492	10383	288.298			
Total	4485712.000	10404				
Corrected total	3092571.509	10403				

R Squared = .032 (Adjusted R Squared = .030)

years. We have to bear in mind that 10 and 25 are average ages. For some individuals the formative period will start and end somewhat earlier or later. In social research the hypothesis has been put forward that at about the age of the, children start to acquire values, norms, attitudes and behavioral patterns. This does not primarily happen as a consequence of socialization in their parental home.” (p. 15)

All studies found empirical evidence for the impact of technology generations on domestic use of old and new media (for more information on the role of technology in everyday life, see Silverstone & Haddon, 1996; Hirsch & Silverstone, 2003; Haddon, 2004, 2011; Loos et al., 2008; Loos, 2012). However, they each examined different aspects of technology use.

Sackmann et al. (1992a/b) focused on household appliances (car, bicycle, TV, radio, record player, PC, washer, cassette recorder, motorbike, CD player, tape recorder) and found the following technological generations: the mechanical generation (<1938), the household revolution generation (1939-1948), the technology spread generation (1949-1963) and the computer generation (1964-1979), each characterized by different behavior “regarding the acquisition of goods and the ability to use them” (Sackmann, 1996, p.306).

Sackmann & Winkler (2013) identified four technological generations: the mechanical generation (<1930), the household appliances generation (1930-1945), the entertainment appliances generation (1946-1960), and the communication appliances generation (>1960) in relation to the possession and usage of, and attitude towards household, leisure and communication appliances.

User interfaces of electronic devices (telephone, TV, video recorder) formed the core of the empirical study conducted by Docampo Rama et al. (2001), who distinguished two technological generations: the electro-mechanical generation (people born before 1960) and the software generation (born in 1960 or later).

Docampo Rama et al. (2002) went on to investigate the use or non-use of the remote control (= display versus menu interaction style) to operate information, communication and entertainment appliances in a subsequent study and identified the same two technological generations as in her previous research, i.e., the electro-mechanical generation (people born before 1960) and the software generation (born in 1960 or later).

In the study conducted by Lim (2010), the focus was on the past experiences and familiarity people had with a variety of everyday domestic consumer products, such as radios, cameras, telephones, vacuum cleaners and TVs. The following technology generations were identified: the electro-mechanical [EM] generation (aged 46 and older) and the digital software [DS] generation (aged 45 years and under). The aspect of the private use of information and communication technologies (internet use, e-mail, social media) was researched by Sackmann & Winkler (2013), who found five technology generations: the mechanical generation (born before 1938), the household revolution generation (age group born 1939-1948), the technology spread generation (born 1949-1963), the computer generation (age group born 1964-1979) and Internet (people born later than 1979).

Van der Goot et al. (2018) were able to distinguish the newspaper generation (born 1930-1957), the

The impact of 'technology generations' on older adults' media use

Table 7. Regression analysis: predictors explaining variance of the importance of traditional media index.

ANOVA ^a					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	13316.852	4	3329.213	3.964	.003 ^b
1 Residual	4986661.198	5938	839.788		
Total	4999978.050	5942			

a. Dependent Variable: Traditional_media_Index

b. Predictors: (Constant), technology generations, educational attainment_categories, 1-man, retired_dummy

Coefficients ^a					
Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	31.182	1.627		19.170	.000
1 – man (sex_dummy)	.353	.760	.006	.465	.642
retired_dummy	-.226	.957	-.003	-.236	.813
educational level	.198	.433	.006	.457	.648
technology generations	2.296	.622	.051	3.690	.000

a. Dependent Variable: Traditional_media_Index

TV generation (born 1958-1977) and the Net generation (born 1978-1995). We refer to Table 9 for a specification of the technology generations identified by the seven empirical studies.

While the results of the previous seven empirical studies (for a more detailed overview of these studies we refer to Table 9 clearly provide empirical evidence for the existence of technology generations, we wish to emphasize that they are not deterministic and that the following points should be taken into consideration:

(1) Not all older people in a specific technological generation necessarily have the same characteristics. Or, as Sackmann & Winkler (2013) state: "Generational differences in technological practice are not coercive features for individual, but just probabilistic relations, open to individual and collective change and social structures." (p. 494)

(2) It may well be that age also plays a role in differences in technology usage patterns. Age effects were addressed in three of the seven empirical studies we reviewed:

Van de Goor & Becker (2001) [2] argue that "since Sackmann & Waymann did not study the possibility of age effects, they were not able to conclude if the found effects really constituted technology generation effects or age effect" (p. 17). In their own study, they conclude: "We (...) found age to have an effect on the possession of multi-layered (communication) appliances. This implies that with advancing age, future elderly might purchase a smaller amount of these appliances." (p. 125)

Docampo Rama et al. (2001) state [3]: "(...) both age and generation are based upon the year of

birth, how we can operationally distinguish between age effects and (technology) generation effects? Following general sociological methodology (Glenn, 1977), different generations are defined on the basis of rather sudden, discontinuous changes in society such as wars, economic depressions etc., and consequently generation effects should reflect such discontinuity. Age effects are different since these are assumed to be rather continuous" (p. 28). They also argue: "In the present study, we will try to separate age effects from generation effects by choosing sub-

jects from suitable age cohorts such that the transition from electromechanical to software style user interfaces is suitably covered. If performance declines continuously with birth cohort, we will interpret this as an age effect, but if it declines discontinuously with birth cohort, we will interpret this as a generation effect. More specifically, we will look for any discontinuity appearing at the birth cohort of about 1960, when the predefined EM-generation changed into the S-generation; Combined continuous and discontinuous effects of age and generation may also occur but will be more difficult to analyze operationally" (pp. 28-29). Docampo Rama et al. (2001) conclude that "(...) task duration has been found to increase monotonously with increasing age in conformance with the literature, and seems unrelated to generation differences." (p. 39).

In their subsequent study, Docampo Rama et al. (2002) [4] argue that "empirically, this generation effect is difficult to distinguish from an age effect, as both technology generations and age are measured by the subject's year of birth. Sociological methods tackle this problem by analyzing an age effect, whereas a discontinuous trend indicates a generation effect (Glenn, 1977)," (p. 36). In the presentation of their empirical results, nowhere do they discuss any age effect.

(3) It is also important to note that, although older adults may be slower to purchase new technology than the young (Sackmann et al. 1992a/b; Van de Goor & Becker, 2001), they nonetheless tend to do so in the end. As Rogers (2003) writes (see also Sackmann & Waymann, p. 496), successful innovations are first

The impact of ‘technology generations’ on older adults’ media use

Table 8. Regression analysis: predictors explaining variance of importance of new media index.

ANOVA ^a					
Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	25279.075	4	6319.769	21.491	.000 ^b
Residual	2847206.730	9682	294.072		
Total	2872485.805	9686			

a. Dependent variable: New_Media_Index

b. Predictors: (Constant), technology generations, educational attainment_categories, sex_dummy, retired_dummy

Coefficients ^a					
Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	9.764	.751		13.005	.000
1-man (sex_dummy)	2.130	.351	.062	6.067	.000
retired_dummy	-1.106	.439	-.027	-2.518	.012
educational level	.986	.200	.050	4.931	.000
technology generations	-.764	.294	-.028	-2.596	.009

a. Dependent variable: New_media_Index

used by ‘innovators’, ‘early adopters’, then by the ‘early majority’, followed by the ‘late majority’ and finally even by the ‘laggards’. And Van de Goor & Becker (2001) argue: “Once members of an earlier generation have crossed the barrier and purchased a relatively complex appliance, they start to use it and use it equally often as member of later generations.” (p. 124). Once they start using it, they build up experience that helps them to use the new technology. Hence, while a person may not have been exposed to a certain technology during his or her formative years, this can be compensated for by learning how to use it at a later stage. Hill et al. (2011) and Loos (2012) show that experience is more important than age when it comes to use of the internet at a later age. “It appears that daily internet use has far more impact on our navigation patterns than does the age. This shows that age is not the explanatory variable for the navigation patterns in information search behavior. Experience with internet plays a much more important role. In short, even if a person was not exposed to the internet during his or her formative years, this can be compensated by learning to work with the internet at a later age. Hence, in the case of navigation patterns the socialization theory does not apply to all senior citizens.” (Loos, 2012, pp. 14-15)

(4) What also helps older people to start using a new technological device is enhanced user friendliness (e.g., the iPad). In other words, as Sackmann wrote, “after the innovation phase, intra-cohort development leads to a decrease in the distinctions between generations.” (Sackmann, 1996, p. 306)

METHODS

Sample

Traditional media are increasingly being challenged by the new communication practices of internet-based media. We therefore proposed to investigate older audience and processes of media displacement (Nimrod, 2017 using data from the first wave of the ACT project: Older audiences in the digital media environment: A cross-national longitudinal study. Wave 1 Report 1.0’ (Loos et al. 2018). To our knowledge, this longitudinal study, which is investi-

gating older audiences (aged 60 and above) and their media use within an inter-cultural context, with data being collected in three waves over a five-year period, is an unique attempt to map the dynamics of media use by older people. In the seven countries in which the study is being conducted - Austria, Canada, Denmark, Israel, the Netherlands, Romania and Spain - the samples consisted of Internet users aged 60 and over. Local companies were involved in the data collection process, which was performed using online surveys, except in Romania. There, the survey was conducted using Computer Assisted Telephone Interviews (CATI), as the percentage of Internet users among older people in Romania was estimated to be below 20 (Eurostat, 2017). Quota samples (using age and gender quotas) were created in each country with the aim of producing samples representative of the country’s older online population. The overall sample (N=10527) consisted of Internet users aged 60 and older. Participants’ ages ranged from 60 to 101, with a mean of 67.5 years (SD = 6.07), of whom 52% were men; 57% of the participants had attained a higher education or full university education; 45% reported having income higher than the average in their country and 15% declared their income to be lower than average. 72% were retirees and 13.3% worked fulltime.

Data analysis

Based on the concept of ‘technology generations’ suggested by Sackmann & Winkler (2013), we identified in the current data base the following three technology generations: the ‘technology spread generation’ (born between 1949 and 1956), the ‘household revolution generation’ (born between 1939 and 1948) and the ‘mechanical generation’ (born before 1939).

The impact of 'technology generations' on older adults' media use

Table 9.1. Review of empirical studies in the field of technology generations.

Empirical study	Year(s) data collection	Country / Countries	N	Method	Technology Generations (date of birth) and main results	Formative years	Domain
Research report: Sackmann et al. (1992a/b) Results also published in: Sackman (1993) Weymann & Sackmann (1993) Weymann (1994) Weymann (1994) Sackmann (1996)	1992	East and West Germany	N = 1000 (East Germany) N = 1000 (West Germany)	Survey	<p>Mechanical (<1938)</p> <p>Household revolution (1939-1948)</p> <p>Technology spread (1949-1963)</p> <p>Computer (1964-1979)</p> <ul style="list-style-type: none"> • "These generations differ with respect to conjunctive experiences of technology acquired during the course of life. Dissimilarities in the adaptation of technological innovations correlate with membership in different generational groups." (Sackmann, 1996, pp. 305-306) • "The diffusion of technological innovations is connected to enduring generational differences regarding the acquisition of goods and the ability to use them." (Sackmann, 1996, p. 306) • "The diffusion of cars and computers in particular is characterised by long-standing inter-cohort differentiation. (Sackmann, 1996, p. 306) • After the innovation phase, intra-cohort development leads to a decrease in the distinctions between generations." (Sackmann, 1996, p. 306) 	Between the age of 15 and 25 years old (Weymann & Sackmann, 1993, p. 726)	Household appliances: car, bicycle, TV, radio, record player, PC, washer, cassette recorder, motorbike, CD player, tape recorder

We will discuss the differences related to media use and preferences between these three technology generations and across the seven countries.

The SPSS v20 software package was used to analyze the data. First, we analyzed the differences between the three technology generations in terms of socio-demographic characteristics: country of origin, gender, education, and income and work status. Chi-square non-parametric tests were used to record these differences. Then, we used descriptive statistics to determine the percentage of older people using different media (traditional media and new media) within the three technology generations and we recorded differences of media use using one-way analysis of variance (ANOVA) and Fisher's least significant differences (LSD) tests.

Next, we created two indexes to investigate the preferences for media use among the members of the three technology generations:

- (1) The Importance of traditional media Index = Total time spent using different traditional media: (watching television on a TV set + listening to the radio on a radio set + reading newspapers/magazine in the printed version); and
- (2) the Importance of new media Index = Total time spent using different new media: watching television on a computer + watching television on a mobile phone+ listening to the radio on a computer + listening to the radio on a mobile phone+ reading online versions of newspapers/magazine)

Note that participants were asked to log their media use from the previous day and that minutes spent on different media were used to calculate the two Indexes. Next, we used two-way factorial ANOVA to investigate the importance of traditional vs new media among users in these three technology generations across the seven countries. Finally, a series of linear regressions were conducted to explore factors that predict media preferences (traditional versus new media), taking the technology generations and the socio-demographic data into account.

RESULTS

Background characteristics and countries among the three technology generations

The three technology generations were not equally distributed in our sample (Ntotal =10527), reflecting an unequal distribution of older Internet users in different age cohorts. The 'technology spread generation'

The impact of ‘technology generations’ on older adults’ media use

Table 9.2. Review of empirical studies in the field of technology generations.

Empirical study	Year(s) data collection	Country / Countries	N	Method	Technology Generations (date of birth) and main results	Formative years	Domain
Van de Goor & Becker (2001)	End 1997- beginning 1998	The Netherlands	N = 1015 (between 30 and 79 years old)	A computer assisted face-to-face survey about possession and usage of appliances, and a 7 items sum scale for attitude towards technology	<p>Mechanical (<1930)</p> <p>Household appliances (1930-1945)</p> <p>Entertainment appliance (1946-1960)</p> <p>Communication appliance (>1960)</p> <ul style="list-style-type: none"> • “We can conclude that those technologies one grew up with still have some influences on the type of appliances one owns and uses at the present time, though to a smaller extent than we expected.” (p. 124) • “Technology generation influences mainly bear upon the decision to purchase. Once members of an earlier generation have crossed the barrier and purchased a relatively complex appliance, they start to use it and use it equally often as member of later generations.” (p. 124) • The greatest gap between technological generations exists between people who were born before 1946 in the one hand and people who were born after 1945 on the other. Those born after the war, who experienced the diffusion of entertainment appliances during the formative period but did not get acquainted with digital, multi-layered appliances at that time, have caught up with those who did experience the digitization of society in their formative years in nearly every respect. They purchase and use most multi-layered (communication appliances) equally often.” (p. 124) • “People who were born before 1946 were not able to completely catch up on these new appliances. Those who grew up at the time when household appliances began to spread were much more able to deal with single-layered entertainment appliances than the mechanical generation. Both technology generations, however are equally hesitant when it comes to buying the current communication and information technology. This, however, is not the result of a negative attitude towards technology in general. These groups are less likely to purchase these appliances because they expect them to be difficult to handle. Since that is the main problem, measures should be taken to persuade people to buy appliances. Once an application is bought, usage often follows as a matter of course. For complex appliances such as the VCR the first serious attempt to use it ensures further usage.” (p. 124) • Age effect: “We also found age to have an effect on the possession of multi-layered (communication) appliances. This implies that with advancing age, future elderly might purchase a smaller amount of these appliances.” (p. 125) 	Between the age of 10 and 25 years old (p. 15)	<ul style="list-style-type: none"> • Possession and usage of domestic appliances and entertainment and communication appliances • Attitudes towards technology

is the largest one, accounting for 56.3% of the total sample, the ‘household revolution’ generation comprises 36.4% from our sample, while the ‘mechanical generation’ is the smallest, compris-

ing a mere 7.3% of our sample (with percentages ranging from 12.2% in Denmark to 2.6 % in Austria). The differences between the three technology generations in our sample reflect the

The impact of 'technology generations' on older adults' media use

Table 9.3. Review of empirical studies in the field of technology generations.

Empirical study	Year(s) data collection	Country / Countries	N	Method	Technology Generations (date of birth) and main results	Formative years	Domain
Docampo Rama, de Ridder & Bouma (2001)	1997-1998	The Netherlands	<ul style="list-style-type: none"> Experiment 1 (software-based simulation of a videophone with either a one-layered or a two-layered use interface): N = 80 (between 25 and 75 years old) Experiment 2 (simulation of a mobile phone featuring a three-layered use interface and two tasks): N = 40 (between 25 and 75 years old) 	Experiments	<p>Electro-mechanical-generation (<1960) Software generation (<1960)</p> <ul style="list-style-type: none"> • The difference between the electro-mechanical-generation and the software-generation shows up in the higher number of mode errors in the electro-mechanical-generation. Within the electro-mechanical-generation, no age effect in mode errors has been found." (p. 38) • Mode error performance: "subject who experienced software style user interfaces in early adulthood performed better than older subjects who did not have such earlier experience. Within the older subjects, no age effect in error performance was found." (p. 25) • Main conclusion: "Experiences in the formative period before the age of 25 years are more persistent than later ones." (p. 25) • Age effect: "(...) task duration has been found to increase monotonously with increasing age in conformance with the literature, and seems unrelated to generation differences." (p. 39) 	Between the age of 10 and 25 years old (p. 27)	User interfaces of electronic devices: telephone, TV, video recorder
Docampo, Rama & van der Kaden (2002)	1998	The Netherlands	N = 1015 (between 30-and 79 years old)	Survey	<p>Electro-mechanical generation (1930-1960) Display generation (1960-1970)</p> <p>In the electro-mechanical generation the remote control was not used by most of its members (preferred style = menu style) while a majority (83 percent) of the display generation has used the remote control (preferred style = display style) in their formative period. (p. 51)</p>	Between the age of 10-25 years old (p. 36)	Use or non-use of the remote control (= display versus menu interaction style) for information, Communication and Entertainment Appliances

The impact of ‘technology generations’ on older adults’ media use

Table 9.4. Review of empirical studies in the field of technology generations.

Empirical study	Year(s) data collection	Country / Countries	N	Method	Technology Generations (date of birth) and main results	Formative years	Domain
Lim (2010)	?	UK	Exploratory case study: N = 6 Electro-mechanical (EM) generation (46 years and older) N = 6 Digital software (DS) generation (45 years and below) Cross-sectional study: n = 35 (between the ages of 19 and 83)	Exploratory case study (semi-structured interviews, content analysis) Cross-sectional study (experiment, survey)	EM generation (ca. 1930 to ca. 1960) DS generation (after ca. 1960) “Older adult participants from the EM era in particular find ICT products with multi-layered interface difficult to use.” (p. 204)	Between the age of 10-30 years old (p. 204)	People’s past experiences and familiarity with a variety of everyday domestic consumer products, such as: radios, cameras, telephones, vacuum cleaners and TVs

heterogeneity related to the Internet use among older adults (Loos, 2012): the oldest-old population (here described as ‘mechanical generation’) having the lowest percentage of Internet users, regardless the countries we take into consideration.

The data reveal gender differences between the three technology generations. As we move from the ‘technology spread generation’ to the ‘household revolution generation’ and the ‘mechanical generation’, we find slightly more male Internet users than female. Older Internet users tend to be mainly people who have attained an upper secondary or higher educational level across all three technology generations. Less than 10% of those in our sample fell into the category “up to lower secondary” education. Nonetheless, there are several differences in level of education between the three technology generations, with less well educated participants tending to be more concentrated in the ‘mechanical generation’ than in the two other technology generations. The interaction effect between gender and education shows that we have more women using the Internet than men, except in the category of users that have a “full academic” education, where more men were found to use the Internet than women. The differences between the percentages of, on the one hand, men and on the other hand, women with a “full academic” education using the Internet were found to increase from 5% in the ‘technology spread generation’ to 10 % in the ‘household revolution generation’, and rising to 15% in the ‘mechanical generation’. Income categories did not account for any significant differences in the three technology generations considered here. Regarding retirement status, as could be expected, the percentage of retired persons among members of the ‘technology spread generation’, in which more than one third of participants (37.6%) were still working either full or part time, was much lower than in the ‘household revolution generation’ and the ‘mechanical generation’, where respectively over 93% and 96% of the respondents were retired. We therefore expected differences in technology use among the three defined technology generations to be influenced by the differences in work status, education, and gender described here and controlled for these in a further analysis. We also tested whether preferences for using different media are better explained by age or by generation technology.

Media use among members of the three technology generations

We analyzed differences in media use (traditional and new) and we recorded the differences found between the three technology generations (Table 4). Indeed, the use of traditional media by the ‘technology spread generation’ tended

The impact of 'technology generations' on older adults' media use

Table 9.5. Review of empirical studies in the field of technology generations.

Empirical study	Year(s) data collection	Country / Countries	N	Method	Technology Generations (date of birth) and main results	Formative years	Domain
Sackmann & Winkler (2013)	2004 2009	Germany	N = 23.000 individuals in 12.000 households	ICT survey (Statistical Bureau of Germany focused on the private use of information and communication technologies)	<p>Mechanical (<1938)</p> <p>Household revolution (1939-1948)</p> <p>Technology spread (1949-1963)</p> <p>Computer (1964-1979)</p> <p>Internet (>1980)</p> <ul style="list-style-type: none"> • "Generations differ in technical habitus (possession), modes of usage and symbolic meanings given to new technology in general and their general collective technological identity." (p. 494) • "(...) non-users of private internet use are more concentrated in older technology generations in advanced diffusion stages: thus generational differences increase over time." (p. 500) • "At present, elder citizens still consist of technology generations shaped by mechanical and electro-mechanical equipment. However, if these generations are persuaded to go online, applications that are similar to older forms like email (letter) and search machines (encyclopedias) are adopted quickly." (p. 501) • The probability of email use are significantly similar among generations older than the computer and the internet generation. (p. 500) • "The internet generation uses internet and social media more than the computer generation." (p. 500) • "Younger technology generations are more likely to use social media and these differences in use have become greater over time." (p. 500) 	Between the age of 15 and 25 years old (p. 494)	Private use of information and communication technologies: internet use, e-mail, social media
Van der Goot, Rozendaal, Oprea, Ketelaar & Smit (2018)	Second half of July 2012	Germany (n=963) Spain (n=975) UK (n=977) USA (n=943) France (n=957) The Netherlands (n=969)	5.587	Survey	<p>Newspaper generation (1930-1957)</p> <p>TV generation (1958-1977)</p> <p>Net generation (1978-1995)</p> <ul style="list-style-type: none"> • Advertising attitudes: "The net generation was on the positive end, whereas the newspaper generation was usually the most negative." (p. 1) • Advertising avoidance: "Generational patterns were less present and consistent." (p. 1) <p>Frequency of media use: Generational patterns were similar in all six countries (pp. 13, 14)</p>	<p>Paper mentions the role of the formative years (p. 3) but does not specify the age range.</p> <p>Advertising attitudes</p> <p>Websites, Social Media, Mobile, Newspapers</p> <p>Frequency of media use</p>	

The impact of 'technology generations' on older adults' media use

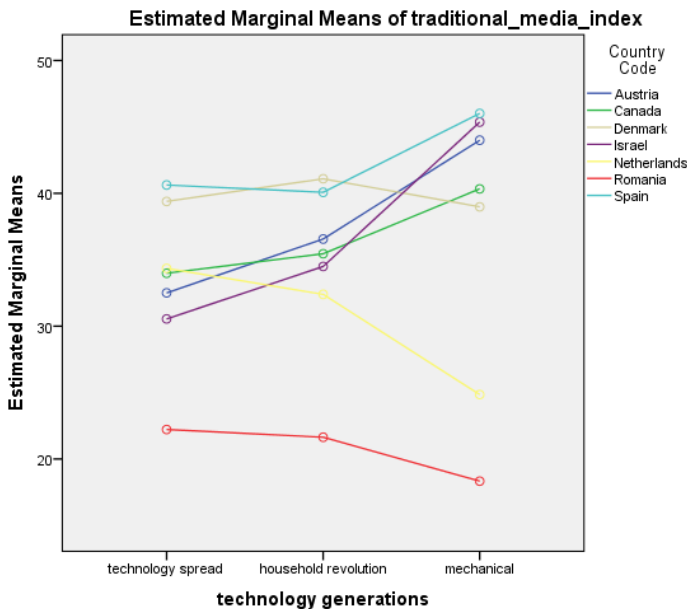


Figure 1. Profile plot of technology generations and country of origin on the importance of the traditional media Index.

to be lower than by the 'household revolution generation' and the 'mechanical generation'. As we move from the 'mechanical generation' to the 'technology spread generation', the percentages of people watching TV on a TV set, reading printed versions of newspapers or books or using a landline to communicate decreased.

Differences between the three technology generations also emerge when comparing percentages of new media use. Moreover, the effect size of technology generations is stronger when it comes to the mobile phone applications. Hence, the use of new media and different mobile applications - from sending SMSs to chatting (instant messaging), and the use of social network sites or games on mobile phone - by members of the 'technology spread generation' is higher than by members of the 'household revolution generation'; but is higher in turn among members of the 'household revolution generation' than among those of the 'mechanical generation'. An interesting finding meriting further discussion in future studies is the relatively large percentage of older people across all three technology generations reading newspapers/magazines online (ranging from 52.3% in the 'technology spread generation' to 42.6% in the 'mechanical generation').

Differences between the technology generations in the importance of traditional vs new media in different countries

The data presented in Tables 3 and 4 offer support for the concept of 'technology generations' and for a generational effect in the use of tradi-

tional and new communication media. Still, the generational effect on different media use might differ in certain respects in each of the countries from our sample. To investigate this, we performed a two-way factorial ANOVA, using the Importance of traditional media Index and the Importance of new media Index as dependent variables, and technology generation and country of origin as main factors and interaction factors.

The country of origin generates a significant main effect on the preference of older adults for traditional media (the Importance of traditional media Index) - $F(6, 6328) = 11.894, p < .011$, partial $\eta^2 = .011$ - and an interaction effect of country and technology generations is also seen in the preference of older adults for traditional media: $F(12, 6328) = 2.213, p < .001$, partial $\eta^2 = .004$. Still,

when assessing preferences for traditional media (Table 5), the main effect of country of origin was higher than the interaction effect of country of origin and technology generations.

We found no separate effect of the generations on the preferences for using traditional media formats, $F(6, 6328) = 11.894, p = .009 < .01$, partial $\eta^2 = .011$, thus accepting the null hypothesis of the relation between technology generations and preferences for using traditional media at older people, $F(2, 6328) = 2.212, p = .11$, partial $\eta^2 = .001$. The main effect of the country of origin on the preferences of older adults for traditional media could be also seen in the plot resulting from the analysis (Figure 1). Members of the 'mechanical generation', particularly in Romania and the Netherlands, showed less preference for traditional media, compared to Spain, Austria and Israel.

We found no main effect of generations on preferences for using new media formats, $F(2, 10403) = .540, p = .540$, partial $\eta^2 = .000$, and no interaction effect of country of origin and generations, $F(12, 10403) = 1.081, p = .372$, partial $\eta^2 = .001$ (Table 6). Yet, country of origin was found to have a separate main effect on preferences for using new media, $F(6, 10403) = 23.902, p < .001$, and the effect size of the country of origin is large ($\eta^2 = .014$). We plotted the different patterns of media use for the three generations in each of the countries in our sample (Figure 2). Analyzing preferences for using new media for the three generations yielded similar profiles for Romania and Canada on the one hand, and the

The impact of ‘technology generations’ on older adults’ media use

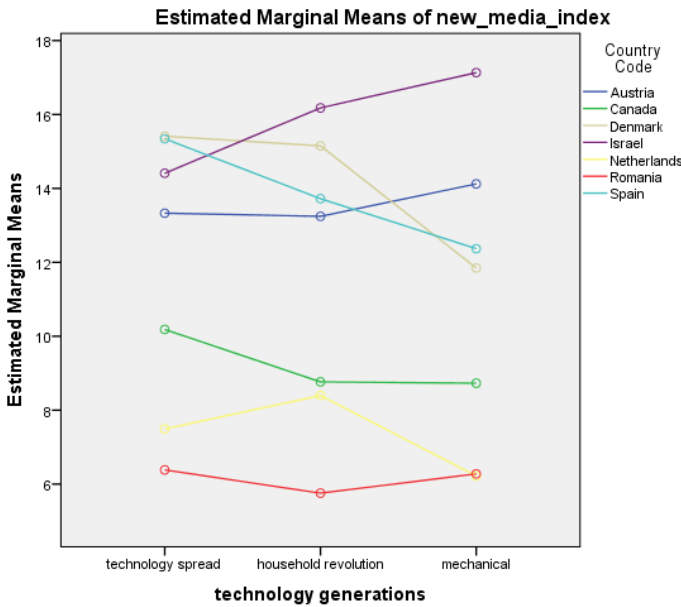


Figure 2. Profile plot of technology generations and country of origin on the importance of the new media index.

Netherlands and Denmark on the other.

Our data show that technology generation has a significant main effect on the preference for using traditional media (minutes spent using different traditional media formats). Also socio-demographic variables: country of origin, gender, working status and education play a role in the way people adopt and use different media formats (Table 3). To analyze the importance of technology generation in explaining the variance in minutes spent on traditional media, we conducted a linear regression using technology generation, gender (dummy, 1-man, 0-woman), educational level (educational attainment categories listed in Table 3) and working status (dummy, 1-retired) as predictors and the Importance of traditional media Index as a dependent variable. We also ran a similar model using age as the continuous variable instead of the technology generation (discontinuous variable).

The results of the linear regression analysis (Table 7, $F(4, 5942) = 3.964, p = .003 < 0.1$) show that technology generation remains a significant predictor for time spent by older adults on different media formats, even after controlling for gender, working status and education ($\beta = 2.296, t = 3.690, p < .001$). Still, this model can account for 5% of the total variation in traditional media use ($R^2 = .05$) and explains the similarities in variations in traditional media use across the seven countries in which the analysis was conducted. From the ‘technology spread generation’ to the ‘household revolution generation’, through to the ‘mechanical generation’, the length of time

in minutes spent by older adults using traditional media formats, regardless of gender, education categories and working status (retired or not), increased by 5%. Note that the socio-demographic predictors that account for differences between technology generations in media use (adoption) – see Table 2, do not explain the variance of time people spent on traditional media formats.

When running the analysis using age as the predictor (continuous variable) instead of technology generations, we obtained similar results ($R^2 = .05$); the regression model did not improve, showing that both age and generation technology could account for similar differences in the variance of the dependent variable: preferences for traditional media use.

Different results were found when running a linear regression using the same predictors: country of origin, gender, working status and education, technology generations and the Importance of new media Index (Table 8) as the dependent variable. Variance in each of the socio-demographic variables, including the technology generations, significantly influenced the variance of the dependent variable (the Importance of new media Index), $F(4, 9686) = 21.491, p < .001$. The model accounted for 10% of the total variation of new media use ($R^2 = .098$). From the ‘technology spread generation’ to the ‘household revolution generation’, through to the ‘mechanical generation’, the length of time in minutes spent by older adults using new media decreased by 2.8% after controlling for gender, working status and education ($\beta = -.764, t = -2.596, p = .009 < .01$). In addition, men spent 6.2% more minutes on new media compared to women, regardless of educational level, working status or technology generation ($\beta = 2.130, t = 6.067, p < .001$). Moreover, people with high levels of educational attainment spent more time on new media than those having a lower or medium educational level ($\beta = 9.986, t = 4.931, p < .001$). Educational level accounts for 5% of the variance in the length of time spent using new media, when the other predictors are held constant. Similarly, being retired was found to impact the length of time in minutes spent using new media, shortening this by approximately 2.7% compared to older adults with jobs, after controlling for socio-demographic factors ($\beta = -1.106, t = -2.518, p = .012 < .05$). Again, when running the analysis using age instead of age category (technology generation) as a con-

The impact of 'technology generations' on older adults' media use

tinuous variable, we saw similar results (R square =.09), with age (continuous variable) accounting for similar differences in the dependent variable, i.e., preferences for new media use.

In the case of the Importance of new media Index, we found an effect of technology generation, when controlling for gender, education and working status (being retired). As country of origin plays an important role in shaping older persons' new media use (Figure 2), we can say that the effect of technology generations on the preferences for new media are mediated by gender, education and working status (being retired), in the particular contexts of each country.

CONCLUSIONS, LIMITATIONS, AND IMPLICATIONS FOR FUTURE RESEARCH

Conclusions

RQ1: Are there indeed previous studies providing empirical evidence for the existence of technology generations?

Though the results of the previous seven empirical studies clearly provide empirical evidence for the existence of technology generations, it should be emphasized that that they are not deterministic and that not all older people in a specific technological generations necessarily have the same characteristics. Generational differences in technological practice are probabilistic relations (Sackmann & Winkler, 2013). Age may not be ruled out as playing a role in the differences related to technology usage patterns. Three out of the seven empirical studies we reviewed addressed these age effects. Although older people may be slower than younger ones to purchase new technology (Sackmann et al. 1992a/b; Van de Goor & Becker, 2001), they ultimately do end up doing so. Another point to take into consideration is that even though a person may not have been exposed to a particular technology during his or her formative years, as time progresses, this can be compensated for by learning how to use this technology later in life. As Hill et al. (2011) and Loos (2012) show, experience is more important than age when it comes to using the internet at a later age. Daily internet use has far more impact on our navigation patterns than age. What also helps older people to start using a new device is enhanced user-friendliness (e.g. iPad).

RQ2a: Does the extent to which traditional media are used differ between the three technology generations?

We recorded lower percentages of traditional media use by members of the 'household revolution' generation than by those of the 'mechanical generation', and lower still by members of the 'technology spread generation'; in other words, the percentage of people watching TV on a TV

set, reading printed versions of newspapers or books or using a landline to communicate is shrinking. Being part of one of the three technology generations is a significant predictor of preferences for using traditional media (time spent using traditional media formats), while older people's gender, working status and educational attainment level do not account for significant differences in time spent on traditional media. Still, age (the birth year) accounts for an effect similar to technology generation on the variance in traditional media differences. In the sociological literature, a generation effect is difficult to distinguish from age effects (Docampo Rama et al., 2002). In the current study, we found that the effect of both age and generation accounts for the same variance in traditional media use by older people, whereas gender, education and working status do not play a role in the equation. Indeed, the effect is rather small: both the continuous variable of age and generation each separately account for approximately 5% of the variance in time spent on traditional media formats.

RQ2b: Does the extent to which new media are used differ between the three technology generations?

The percentage of older adults using new media is the highest in the 'technology spread' generation and the lowest in the 'mechanical generation', and this trend is most markedly visible in the use of mobile phone applications: SMS, chatting (instant messaging), social network sites and games on mobile phone. Members of all three technology generations were found to read newspapers/magazines online, ranging from 52.3% in the 'technology spread generation' to 42.6% in the 'mechanical generation'. Being part of one of the three technology generations could explain the preferences in a person's use of new media (time spent using new media formats), after controlling for gender, education and working status. However, in this case, gender (being male), working status (being employed) and education (high attainment level) were shown to be important predictors that explained between 3% and 6% of the variance in time spent on different new media. Again, the effect of age is difficult to isolate from that of technology generation, as both could be interchangeably used as predictors in explaining new media use.

RQ3a: Do older people belonging to different technology generations and from different countries have different media preferences?

Technology generation is a concept that has not been tested in cross-cultural research project before. In the current study, we used data gathered on adults aged 60 and over in seven countries: Austria, Canada, Denmark, Israel, the Netherlands, Romania and Spain. Country of origin was

The impact of 'technology generations' on older adults' media use

found to generate a significant main effect on the preference of older persons for traditional media. Members of the 'mechanical generation' showed less preference for traditional media, particularly in Romania and the Netherlands, compared to Spain, Austria and Israel. Also, the country of origin had a separate main effect on older people's preferences for using new media.

RQ3b: Is there an interaction effect between country of origin and technology generation in older people's media use?

We found an interaction effect of country of origin and technology generation on the preference of older adults for traditional media, although the main effect of country of origin was higher than the interaction effect of country of origin and technology generation. As for the preferences for using the new media formats, we found no effect of technology generation, nor an interaction effect of technology generation and country of origin. Yet, country of origin had a separate main effect on preferences for using new media.

In conclusion, when empirically testing the 'technology generation' concept, it proved difficult to isolate the age effect from the cohort effect, and both cohort and age effect overlapped in explaining variances in older people's preferences for different media. When testing this concept in different countries, we found an interaction effect of

technology generation and country of origin in the case of old media preferences, and a main effect of country of origin for preferences in using new media. These results call for a more nuanced view in further empirical testing of generation effect on media use, by taking into account more contextual factors related to country's specificity.

Limitations and implications for future research

The data related to older adults' media use and preferences were self-reported and delivered interesting insights into the existence of technology generations. It would also be interesting to use other methods such as tracking (Fernández-Ardèvol et al., 2019) to see the extent to which actual media use delivers the same results. Unlike other studies in this field that often focus on just one country, our empirical research project on technology generations comprised seven countries (Austria, Denmark, Canada, Israel, the Netherlands, Romania, Spain). However, future empirical studies should include additional (also non-western) countries. A longitudinal approach, following the media use and preferences of an ageing group of people using media that is also becoming older, is another important recommendation. The ongoing data collection for the ACT project (Ageing Communication Technologies) seven countries study in which we are participating will deliver the opportunity to make such an analysis after the third wave in 2020.

Acknowledgements

This paper received funding from the Ageing + Communication + Technology project <http://actproject.ca/> (ref. 895-2013-1018, Social Sciences and Humanities Research Council of Canada) and is also part of the research project BConnect@Home (<https://www.researchgate.net/project/BCONNECTHOME-Making-use-of-digital-devices-in-later-life>), funded by the JTP 2017 - JPI More Years, Better Lives (Grant Agreement 363850).

References

Attewell, P. (2001). Comment: The first and second digital divides. *Sociology of education*, 74(3), 252-259.

Becker, H. A. (1991). Dynamics of Life Histories and Generations Research. In H.A. Becker (Ed.), *Life Histories and Generations* (pp. 1-55). Utrecht: ISOR.

Breitsamer, J. (1976). Ein Versuch zum Problem der Generationen. *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 28(3), 451-478.

Docampo Rama, M., de Ridder, H., & Bouma, H. (2001). Technology generation and age in using layered use interfaces. *Gerontechnology*, 1(1), 25-40.

Docampo, Rama, M., van der Kaden, F. (2002). Characterization of technology generations on the basis of user interfaces. In: R. Pieper, M. Vaarama, & J. L. Fozard, (Eds.), *Gerontechnology – Technology and Aging – Starting into the Third Millennium* (pp. 35-53). Aachen: Shaker Verlag.

Fernández-Ardèvol, M., Rosales, A., Loos, E., Peine, A., Beneito-Montagut, R., Blanche, D., Fischer, B. Katz,

& Östlund, B. (2019). Methodological strategies to understand smartphone practices for social connectedness in later life. In J.G. Zhou & G. Salvendy (Eds.), In: J. Zhou and G. Salvendy (Eds.), *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* (pp. 46-64). Cham: Springer International Publishing.

Fozard, J. L., & Wahl, H. W. (2012). Age and cohort effects in gerontology: A reconsideration. *Gerontechnology*.

Glenn, N. D. (1977). Cohort analyses. In E.M. Uslaner (Ed.) *Qualitative Applications in the Social Sciences*, Beverly Hills: Sage.

Haddon, L. (2004). Information and communication technologies in everyday life: A concise introduction and research guide. Oxford: Berg.

Haddon, L. (2011). Domestication analysis, objects of study, and the centrality of technologies in everyday life. *Canadian Journal of Communication*, 36(2), 311-322

Hargittai, E. (2001). Second-level digital divide: Mapping differences in people's online skills. arXiv preprint [cs/0109068](https://arxiv.org/abs/cs/0109068).

Hill, R. L., Dickinson, A., Arnott, J. L., Gregor, P., & McIver, L. (2011, May). Older web users' eye movements: experience counts. In *Proceedings of the*

The impact of 'technology generations' on older adults' media use

- SIGCHI Conference on Human Factors in Computing Systems (pp. 1151-1160). ACM.
- Hirsch, E., & Silverstone, R. (Eds.) (2003). *Consuming technologies: Media and information in domestic spaces*. London, New York: Routledge.
- Hofmann, D., & Schwender, C. (2007) Biographical functions of cinema and film preferences among older German adults. A representative quantitative survey, *Communications. The European Journal of Communication Research*, 32, 473-491.
- Huysmans, F., Haan, J. de, & van den Broek, A. van den (2004). Achter de schermen: Een kwart eeuw lezen, luisteren, kijken en internetten [Behind the screens: A quarter of a century listening, watching and using the internet]. The Hague: Sociaal en Cultureel Planbureau.
- Lim, C. S. C. (2010). Designing inclusive ICT products for older users: taking into account the technology generation effect. *Journal of Engineering Design*, 21(2-3), 189-206.
- Loos, E. F. (2011). In Search of Information on Websites: A Question of Age? In C. Stephanidis (Ed.), *Universal Access in HCI, Part II* (pp. 196-204). Berlin: Springer.
- Loos, E. F. (2012). Senior citizens: Digital immigrants in their own country? *Observatorio (OBS*) Journal* 6 (1), 1-23.
- Loos, E. F., Mante-Meijer, E. A., Haddon. (Eds) (2008). *The Social Dynamics of Information and Communication Technology*. Aldershot: Ashgate.
- Loos, E. F., & Mante-Meijer, E. A. (2009). Op zoek naar een nieuwe zorgverzekeraar. Een riskante bezigheid? [In search for a new health insurer. A risky business?] *Bestuurskunde*, 18 (2), 63-72.
- Loos, E. F. (2010). De oudere: een digitale immigrant in eigen land? Een terreinverkenning naar toegankelijke informatievoorziening [oratie]. *Older people: Digital Immigrants in their own country? Exploring accessible information delivery* [inaugural lecture]. Den Haag: Boom/Lemma.
- Loos, E. F., Haddon, L., & Mante-Meijer, E. A. (Eds.) (2012). *Generational Use of New Media*. Farnham: Ashgate.
- Loos, E. F., & Romano Bergstrom, J. (2014). Older adults. In J. Romano-Bergstrom & A. J. Schall (Eds.), *Eye Tracking in User Experience Design* (pp.313-329). Amsterdam: Elsevier.
- Loos, E. F., Nimrod, G., & Fernández-Ardèvol, M. (Eds.) (2018). Older audiences in the digital media environment: A cross-national longitudinal study. *Wave 1 Report 1.0*. Montreal, Canada: ACT project. <http://spectrum.library.concordia.ca/983866/>
- Mannheim K. (1997). The problem of generations. In: *Collected Works of Karl Mannheim*, volume 5 (pp. 276-320). London: Routledge.
- Mante-Meijer, E. A., & Loos, E. F. (2008). Risk takers and choice makers: Their (non) use of new media. Age and risk perception during a choice process. In J. Pierson, E.A. Mante-Meijer, E.F. Loos, & B. Sapio (Eds), *Innovation for and by users* (pp. 53-64). Brussel: Office for Official Publications of the European Communities.
- Mares, M. L. & Woodard, E. (2006). In search of the older audience: Adult differences in television viewing, *Journal of Broadcasting & Electronic Media*, 50, 595-614.
- Nimrod, G. (2017). Older audiences in the digital media environment. *Information, Communication & Society*, 20(2), 233-249.
- Norris, P. (2001). *Digital Divide: Civic Engagement, Information Poverty and the Internet Worldwide*. Cambridge: Cambridge University Press.
- PEW (2017). *Tech Adoption Climbs Among Older Adults*, May, 17, 2017. Retrieved from <https://www.pewresearch.org/internet/2017/05/17/tech-adoption-climbs-among-older-adults/>
- Rogers, E. M. (2003). *Diffusion of Innovations*. New York: Free Press.
- Ryder, N. T. (1965). The Cohort as a Concept in the Study of Social Change, *American Sociological Review* 30(6), 843-861.
- Sackman (1993). Versuch einer Theorie der Einnführung technischer Geräte in den Haushalt. In S. Meyer & E. Schulze (Eds.), *Technisiertes Familienleben* (pp. 247-274). Berlin: Sigma.
- Sackmann R. (1996). Generations, Inter-Cohort Differentiation and Technological Change. In: M. Mollenkopf (Ed.), *Elderly People in Industrialised Societies* (pp. 289-308). Berlin: Sigma.
- Sackmann, R., Hüttner, B., & Weymann, A. (1992a). *Technik und Forschung als Thema der Generationen. Schlußbericht des vom Bundesministerium für Forschung und Technologie unter der Nummer 216-3190-SWF00566 finanzierten Forschungsprojekts* [Hauptband] Bremen.
- Sackmann, R., Hüttner, B., & Weymann, A. (1992b). *Technik und Forschung als Thema der Generationen: Schlußbericht des vom Bundesministerium für Forschung und Technologie unter der Nummer 216-3190-SWF00566 finanzierten Forschungsprojekts* [Anlagen] Bremen.
- Sackmann, R., & Weymann, A. (1994). *Die Technisierung des Alltags. Generationen und technische Innovationen*. Frankfurt: Campus Verlag.
- Sackmann, R., & Winkler, O. (2013). *Technology generations revisited: The internet generation*. *Gerontechnology*, 11(4), 493-503.
- Silverstone, R., & Haddon, L. (1996). *Design and the domestication of information and communication technologies: Technical change and everyday life*. Oxford: Oxford University Press.
- Standard Eurobarometer (2017). *Media use in the European Union*. Retrieved from <https://ec.europa.eu/comfrontoffice/publicopinion/index.cfm/Result-Doc/download/DocumentKy/82786>
- Stremersch, S., Muller, E., & Peres, R. (2010). Does new product growth accelerate across technology generations? *Marketing Letters*, 21(2), 103-120.
- Van de Goor, A., & Becker H. A. (2001). *Technology Generations in the Netherlands: a sociological analysis*. Maastricht: Shaker.
- Van der Goot, M. (2009). *Stand van de wetenschap. Televisiekijken in het leven van ouderen: een literatuuroverzicht* [State-of-the-art: Television watching in older people's lives: a literature review]. *Tijdschrift voor Communicatiewetenschap*, 37 (3), 254-267.
- van der Goot, M. J., Rozendaal, E., Oprea, S. J., Ketelaar, P. E., & Smit, E. G. (2018). *Media generations and their advertising attitudes and avoidance: A*

The impact of 'technology generations' on older adults' media use

- six-country comparison. *International Journal of Advertising*, 37(2), 289-308.
- van Deursen, A. J., & Helsper, E. J. (2015). The third-level digital divide: Who benefits most from being online? In *Communication and Information Technologies Annual* (pp. 29-52). Bingley, West Yorkshire: Emerald Group Publishing Limited.
- Weymann, A., & Sackmann, R. (1993). Modernization and the generational structure. Technological innovation and technology- generations in East and West Germany. In: H.A. Becker and P.L. Hermkens (Eds), *Solidarity of generations. demographic, economic and social change and its consequences* (721-743). Amsterdam: Thesis.
- Weymann, A. (1994). *Technological Innovation and Technology-Generations*. In: R.M. Blackburn (Ed.), *Social Inequality in a Changing World* (pp. 28-49). Cambridge.
-