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ORIGINAL INVESTIGATION

Internet use and the digital divide in the English longitudinal study of ageing

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Abstract This paper examines the digital divide in Internet use in later life. We hypothesise that the differential diffusion of domestic information and communication technologies between pre- and post-Second World War cohorts is primarily responsible for this divide rather than either age-associated structural inequalities or age-related intrinsic features of mental and/or physical infirmity. Using data from the English Longitudinal Study of Ageing we show that age/cohort differences in Internet use persist after income, education, employment and health status are controlled for. However, when engagement with domestic information and communication technology and cultural activities are taken into account, age/cohort influences on Internet use decline. These contingent 'age/cohort' effects suggest that 'generational' rather than 'structural' or 'stage of life' influences may be more salient explanations of the (age-based) digital divide.

Keywords Internet · Digital divide · Age/cohort

Introduction

The development of microcomputers and their subsequent link to a globalised communication network was initially welcomed across a broad range of fronts—by industry because of the improved capacity to control and monitor systems of production and distribution, by governments, because of the improved capacity to collect and transmit national and international data and by the public because of the new horizons offered, particularly in home entertainment. Scholars saw the Internet as presaging a radical reordering of society and the decentralising of power relations (Castells 1996).

However concerns over the uneven and unequal take up of the new digital technology were expressed. A new 'digital' divide was seen as exacerbating many of the existing inequalities within national and global society (Norris 2001). The interpretive framework for this divide has varied. On the one hand there are those who stress the uneven development of most technologies, where uptake is fastest amongst the more affluent but which diffuse over time across social and national barriers (Compaine 2001; Powell 2001) while others emphasise the persisting social inequalities upon which the digital divide is superimposed (Luyt 2004; Warshauer 2003).

Although a significant part of this debate concerns the wider global dimensions of the digital divide in Internet access and use (Yu 2006), national surveys have found that within national populations, there exist consistent age/cohort differences (Akhter 2003; Bucy 2000; Chakraburty and Bosman 2005; Chaudhuri et al. 2005; Cutler et al. 2003; Loges and Jung 2001; Peacock and Künemund 2007; Silver 2001). Most of these reports interpret the lower rates of access to and use of the Internet by older adults as a reflection of the structural 'marginality' of older people—their relative poverty, lack of education, greater disability, and exclusion from the work-force—in short "the crystallisation of existing socioeconomic inequalities…within the older population" (Peacock and Künemund 2007 pp 191).

Alternatively, or additionally, the divide is attributed to an age-related disinclination for or voluntary 'social exclusion' from the new technologies, or to an age related difficulty in mastering the technology (Loges and Jung

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2001). Since structural factors alone do not account for the degree of non-use by older people (Akhter 2003; Cutler et al. 2003; Silver 2001) there is an underlying assumption that ageing itself is associated with a disinclination to use the Internet. Loges and Jung (2001) have argued that 'agedness' is reason enough for people not to want to engage with the Internet. They see the differential use of the Internet not so much the result of unequal access arising from socio-economic or generational effects but an intrinsic consequence of 'ageing', which creates a disinclination to want more interaction, more engagement, more choice and more risk (Loges and Jung 2001: p. 559).

Recent analyses of US trends in Internet use between 1997 and 2003 suggest that uptake in access to and use of the Internet is rising amongst the over 60s, implying that age per se may not be quite the barrier that some have assumed (Martin and Robinson 2007: Tables 3, 4). Although, as Martin and Robinson (2007) note, the narrowing of the age gap has been less marked outside North America, recent market survey research does suggest that there may be a rise in the numbers of what some researchers have termed "silver surfers" in western Europe (Axa 2007a, b). Variation in the extent of Internet use amongst the over 50s *between European regions*, for example, exceeds that associated with age/cohort differences (Peacock and Künemund 2007, p. 196), suggesting that socio-cultural factors also play a part in determining the digital divide in later life.

Temporal and geographical variations in the extent of the digital divide seems more explicable from a technology diffusion perspective (Wejnert 2002) and are difficult to reconcile with explanations based upon unchanging psychological or structural differences between age bands. Docampo Rama et al. (2001) have argued that a key generational divide exists between those who grew up socialised into 'mechanical' styles of interacting with consumer products, (lasting up to the 1930s) and those socialised into 'electro-mechanical' styles of interacting with consumer products, (lasting up to the early 1980s) and those socialised toward what they term 'software styles' associated with microcomputers. Viewing the digital divide in cohort/generational terms rather than treating it as either a feature of socio-economic disadvantage or a consequence of intrinsic ageing, it may be argued that adult age/cohorts born in the 1940s may have picked up on domestic information and communication technology (ICT) because of its introduction in the workplace as PCs and exposure to the various types of electronic entertainment provided to teenage children (from Pacman in the 1980s to the Nintendo Wii in the first decade of the twenty-first century) in ways that older age/cohorts did not. On the other hand, adult age/cohorts born in or before the 1920s who retired before the microcomputer became commonplace at work and whose children grew up before they became commonplace at home, have had little exposure to ICT. Consequently, generational and/or period effects might offer a more satisfactory explanation of current differential patterns of Internet use rather than social structural or age-intrinsic factors alluded to in research. If diffusion across age/cohorts is driven by differential levels of generational openness to domestic ICT, continuing growth in Internet use amongst 'seniors' can be anticipated for decades to come, as younger cohorts of retirees replace older ones, making the digital divide a matter of historical contingency rather than an ontological necessity.

The aim of this paper is to examine whether the differences between age/cohorts in Internet use primarily reflect (a) structural differences between the age groups, affecting access to consumer goods more generally—such as low income, limited educational experience, and occupational histories dominated by manual labour (b) age associated mental and/or physical infirmities or (c) 'generational' or 'cohort' differences in exposure to ICT. If the latter, the digital divide may be the result of differential exposure to domestic ICT by different age/cohorts. Older cohorts born in the second and third decades of the twentieth century might be less familiar with a wide range of domestic ICT, from VCRs through to mobile phones, digital TV and DVD players and hence exhibit a slower rate of uptake in PC ownership and Internet use than younger cohorts born during or after the Second World War.

Our hypothesis is that the digital divide, operationalised as the distinction between those people over 50 who use or do not use the Internet, follows a much broader generational divide, not one defined by a 'technology generational divide' (Docampo Rama et al. 2001, p. 28) but one defined by people who are more, and people who are less, active participants in the consumer culture that marks out the "third age" (Gilleard and Higgs 2005). Even after taking account of socio-economic and bio-functional determinants of personal computer ownership and access to the Internet, we expect there to be other factors that determine the take up of domestic ICT, which may loosely be characterised by a 'generational habitus' associated with wider and more diffuse engagement with consumer culture. To test this hypothesis, we have drawn upon data gathered in 2002 from a large and representative sample of the over 50-year-old population of England, the English longitudinal study of ageing (ELSA, Marmot et al. 2002). Our hypothesis was that accessing the Internet is not just a function of age related differences in level of physical, intellectual and functional competence, nor of occupational, educational and financial status, but represents a significant lifestyle marker, reflecting a generational divide within the current over 50-year-old population in Europe and North

America corresponding to the 'mechanical' versus 'electro-mechanical' style of interacting with consumer goods described by Docampo Rama et al. (2001). In pursuing this research question, we wish to give prominence to the idea of generation or cohort as a key factor in explaining the digital divide *within* the older population, a dimension that has hitherto been downplayed.

Method

Sample

The analysis used data from the first wave of the English Longitudinal Study of Ageing (ELSA) that drew its sampling frame from the Health Survey for England (HSE). The ELSA sample was drawn from all three HSE waves of 1998, 1999 and 2001, each of which is representative of the whole English population. Full details of the sample design and response rates for the HSE waves have been reported elsewhere (Erens and Primatesta 1999; Erens et al. 2001; Bajekal et al. 2003). The ELSA sample provides a large and representative sample of people aged 50 years and over living in private households in England.

Fieldwork was carried out between spring 2002 and spring 2003. Data was collected using both Computer Assisted Personal Interviews (CAPI) and a self-completion questionnaire. Sixty-seven per cent of eligible individuals responded. This produced a sample of 12,100 persons including 158 proxy interviews. Proxy interviews and data from younger partners (aged under 50 years) were removed prior to the analysis, leaving a sample of 11, 234 (6,123 women and 5,111 men). Full details of the sample design and the response rates are reported elsewhere (Taylor et al. 2003). All analyses were performed on version 1 ELSA dataset archived with the Economic and Social Science Data Archive.

Measures

We examined 12 primary 'predictor' variables from the ELSA data set. These were respondents' age, which was categorised into four 10 year age cohorts (50–59; 60–69; 70–79 and 80–89 years, respectively) and also into four 10 year birth cohorts (born 1910–1919; 1920–1929; 1930–1939; and 1940–1949), their equivalised household income quintiles, educational status (divided into those with no formal qualifications, those with high school qualifications and those with post-compulsory, college level qualifications), occupational status (professional, intermediate or manual/unskilled work as last job) and employment status (working/seeking work versus retired), disability status (those with no, one or two and those with three or more disabilities), health (those with and those without any longstanding illness), ownership of a personal computer, mobile phone, CD player, and satellite or cable TV, and reported use of the Internet and/or e-mail as the main dependent variable.

In addition, we included information on two 'derived' continuous variables, one to represent 'social networks' based upon the total number of reported close relationships (Janevic et al. 2003:313). the second to represent 'cultural activity' based upon frequency of visiting art galleries, cinemas, museums and theatres (Hyde and Janevic 2003, p. 174) and a third composite mental state measure, a combined score of errors on day, date, month and year (Steel et al. 2003, p. 286). Descriptive statistics for all the variables used in this study are shown in Table 1 below.

Analyses

The principal analytic method employed was multivariate logistic regression analysis with use versus non-use of the Internet as the main dependent variable.

Results

Rates of PC ownership and Internet use by age/cohort

As anticipated there was a significantly lower rate of PC ownership and Internet use amongst the older age/cohorts compared with the younger age/cohorts in the English Longitudinal Study of Ageing data set as Fig. 1 illustrates (Chi square = 1,886.96, *df* 9, $P < 0.001$).

Table 1 Descriptive statistics for key variables

Variable	*N*	Mean	SD	Range
Age (years)	11,260	64.75	9.98	50–89
Age group (decade)	11,260	2.04	1.00	1–4
ADL limitations	11,246	0.88	0.85	0–2
Social network	9,889	7.06	5.51	0–103
Cultural engagement	11,243	4.14	1.11	3–6
Mental status	11,246	3.69	0.72	0–4
Limiting long term illness	11,246	0.35	0.48	0–1
Retired	11,243	1.50	0.50	1–2
Educational status	10,255	1.85	0.87	1–3
Occupational status	11,046	2.17	0.86	1–3
Income quintile	11,239	3.01	1.42	1–5
Own PC	11,246	0.44	0.50	0–1
Own mobile phone	10,330	0.58	0.49	0–1
Own CD player	11,246	0.44	0.50	0–1
Own satellite TV	11,246	0.33	0.47	0–1
Use Internet	10,330	0.31	0.46	0–1

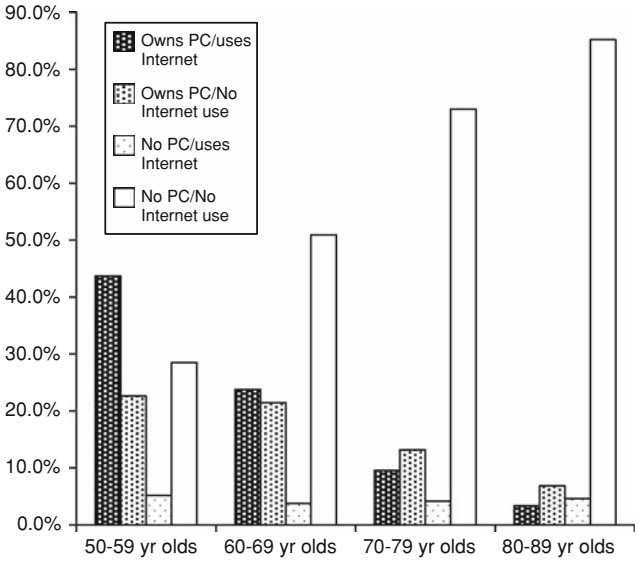

Fig. 1 PC ownership and use of the internet by age decade

Amongst those not owning a PC but who used the Internet, the age/cohort effect was smaller although still significant (Chi square = 127.8, d.f. 3, $P < 0.001$). The proportion of people aged 50–59 year-old using the Internet, who did not own a PC, was 15.4% (207/1,333); amongst 60–69 year-old it was 7.0% (120/1,603); amongst 70–79 year-old, 5.4% (96/1,771) and amongst 80–89 year-old 5.1% (43/848). When the comparison was restricted to those aged 60 and over, the age/cohort effect more or less disappeared (Chi square = 5.21, *df* 2, NS). Amongst those who owned a PC, the age/cohort effect on Internet use was larger (Chi square = 164.24, *df* 3, $P < 0.001$) and remained significant even when confined to those aged 60 and over (Chi square = 26.71, *df* 2, $P < 0.001$) suggesting that the influence of age/cohort on Internet use was strongly mediated by PC ownership.

This was explored in the main analysis which used a multivariate regression analysis, examining the extent to which age/cohort differences in Internet use were attenuated firstly by physical and mental frailty (age/cohort associated differences in mental status, ADL status and the presence/absence of limiting long term illness), secondly by socio-economic structural disadvantage (age/cohort associated differences in educational, employment, occupational, and income status) and thirdly by engagement with domestic ICT (presence in the home of satellite or cable TV, mobile phones, and CD players). Finally, we wanted to examine any additional impact derived from individuals' socio-cultural engagement and their social network size.

Each set of variables was entered into the analysis in blocks, starting with age/cohort, followed by measures of age related 'frailty', socio-economic disadvantage, engagement with domestic ITC, and finally by measures of socio-cultural participation. The results, shown in Table 2,

Table 2 Logistic regression analysis of Internet use in the English Longitudinal Study of Ageing (n = 8,135)

Predictor variables	Block 1		Block 2		Block 3		Block 4		Block 5	
	B (SE)	Odds ratio	B (SE)	Odds ratio	B (SE)	Odds ratio	B (SE)	Odds ratio	B (SE)	Odds ratio
Age/decade 50–59 year-old (n = 3,280)	2.42 (0.14)	**11.29**	2.12 (0.15)	**8.32**	1.86 (0.16)	**6.43**	1.26 (0.18)	**3.55**	1.16 (0.19)	**3.10**
Age/decade 60–69 year-old (n = 2,474)	1.50 (0.14)	**4.46**	1.27 (0.15)	**3.55**	1.17 (0.16)	**3.22**	0.69 (0.17)	**1.99**	0.59 (0.18)	**1.80**
Age/decade 70–79 year-old (n = 1,695)	0.63 (0.15)	**1.88**	0.51 (0.16)	**1.66**	0.51 (0.17)	**1.66**	0.25 (0.18)	1.28	0.19 (0.18)	1.21
Age/decade 80–89 year-old (n = 686)		1.00		1.00		1.00		1.00		1.00
No ADL limitations (n = 3,609)	–	–	0.85 (0.08)	**2.33**	0.49 (0.09)	**1.62**	0.47 (0.09)	**1.60**	0.43 (0.09)	**1.53**
One or two ADL limitations (n = 2,182)	–	–	0.50 (0.08)	**1.64**	0.23 (0.09)	**1.26**	0.22 (0.09)	1.25	0.19 (0.10)	1.21
Three + ADL limitations (n = 2,344)				1.00		1.00		1.00		1.00
No limiting longstanding illness (n = 5,446)			0.12 (0.07)	1.13	0.05 (0.07)	1.06	0.02 (0.08)	1.02	−0.01 (0.08)	0.99
Limiting long term illness (2,689)				1.00				1.00		1.00

Table 2 continued

Predictor variables	Block 1		Block 2		Block 3		Block 4		Block 5	
	B (SE)	Odds ratio	B (SE)	Odds ratio	B (SE)	Odds ratio	B (SE)	Odds ratio	B (SE)	Odds ratio
Mental status			0.23 (0.05)	**1.26**	0.10 (0.05)	1.10	0.08 (0.06)	1.08	0.07 (0.06)	1.08
($n = 8,135$)										
Lowest income quintile					−0.89 (0.10)	**0.41**	−0.69 (0.10)	**0.50**	−0.60 (0.11)	**0.55**
($n = 1,498$)										
Second lowest income quintile ($n = 1,456$)					−0.75 (0.10)	**0.48**	−0.57 (0.10)	**0.57**	−0.47 (0.11)	**0.63**
Middle income quintile					−0.72 (0.09)	**0.49**	−0.64 (0.09)	**0.53**	−0.56 (0.10)	**0.57**
($n = 1,569$)										
Second highest income quintile					−0.41 (0.08)	**0.65**	−0.39 (0.08)	**0.68**	−0.36 (0.09)	**0.70**
($n = 1,737$)										
Highest income quintile						1.00		1.00		1.00
($n = 1,875$)										
Retired					−0.06 (0.08)	0.94	−0.05 (0.08)	0.97	−0.09 (0.08)	0.92
($n = 3,879$)										
Not retired						1.00		1.00		1.00
($n = 4,256$)										
No formal education	–	–			−1.37 (0.08)	**0.26**	−1.35 (0.08)	**0.26**	−1.22 (0.08)	**0.30**
($n = 3,427$)										
High school qualification	–	–			−0.67 (0.07)	**0.51**	−0.70 (0.07)	**0.49**	−0.66 (0.07)	**0.52**
($n = 1,969$)										
Post compulsory/college	–	–				1.00		1.00		1.00
($n = 2,739$)										
No satellite/cable TV	–	–					−0.26 (0.06)	**0.77**	−0.30 (0.06)	**0.74**
($n = 5,398$)										
Satellite/cable TV	–	–						1.00		1.00
($n = 2,737$)										
No mobile phone	–	–					−1.16 (0.07)	**0.31**	−1.14 (0.07)	**0.32**
($n = 3,279$)										
Mobile phone								1.00		1.00
($n = 4,856$)										
No CD player							−0.62 (0.09)	**0.54**	−0.56 (0.09)	**0.57**
($n = 1,856$)										
CD player								1.00		
($n = 6,259$)										
Social network									−0.01 (0.01)	0.99
($n = 8,135$)										
Cultural engagement									−0.07 (0.01)	**0.93**
($n = 8,135$)										
Nagelkerke R^2		0.160		0.192		0.361		0.533		0.537

Odds ratio in **bold** are significant at $P < 0.01$ level or higher

indicate that the effect of age/cohort remained strong after health and socio-economic variation was accounted for, but declined once engagement with domestic ICT was taken into account in Block 4 of the regression analysis and was further attenuated when level of cultural engagement was accounted for, in Block 5.

In a further analysis (not reported here, details from the authors) we examined the relationship between Internet use

and birth decade, rather than age cohort, employing an otherwise identical stepped logistic regression analysis. The results indicated a more powerful birth cohort effect than that observed with age/cohorts, at each step in the analysis, but the pattern of attenuation after entering the fourth and fifth blocks measuring engagement with domestic ICT and levels of cultural participation merely repeated the findings shown in Table 2.

Finally, comparison of the 8,135 respondents whose data were entered into the multivariate analyses with those who had data missing on one or more of the variables (*n* varying from a low of 2,385 with social network data to a high of 3,790 with data on age cohort group, ADL status and limiting long term illness status) indicated that the included sample were significantly different from the excluded, on a number of measures. Those included were more likely to be from younger age cohorts, to be better educated, to be more often from managerial and professional backgrounds, to be in the upper income quintiles, to have more extensive social networks, to have no disabilities and make no errors on tests of temporal orientation. They were not more likely to be retired, however, nor more likely to have satellite TV, and only slightly more likely to own a mobile phone. Compared with the excluded sample, they were not more likely to have lower overall levels of cultural participation. In short, those excluded from the analysis were generally older and poorer, but not so far separated from the included sample in terms of their domestic ICT and cultural engagement.

Discussion

The digital divide within the English longitudinal study of ageing is powerfully associated with age/decade group. Those born nearer the end of the first half of the twentieth century are more likely to use the Internet than those born closer to its beginning. This effect holds true within different income and health status groups, and within the retired and non-retired populations. It is not related to social network size nor is its influence much modified after controlling for a wide range of socio-economic factors potentially disadvantaging older age/cohorts. Is it then simply a matter of age itself?

We hypothesised that a generational rather than an age or structural explanation is warranted to explain the digital divide. The results of the analysis support this since it was only after entering engagement with domestic ICT (excluding PCs themselves) and engagement with contemporary culture that the age/cohort differences fell. Thus, when we included these latter variables, the strongly significant 'age/cohort' effect was confined to differences between 50-year-old; 60- and 70-year-old age/cohorts no longer differed from their 8-year-old compatriots. In a further analysis employing birth decades (not reported here) the divide between those born in the 1940s and those born in earlier decades was the only significant birth cohort effect, after Step 5. These results imply that those born during or just after the Second World War, who grew up during the emergence of a mass consumer society and who are more likely to participate in all aspects of the new consumer culture constitute the key point of the 'digital' divide. Once other variables are introduced, other age/cohort differences decline in importance, a factor difficult to explain in terms of chronological ageing effects.

This exploration of the ELSA database has involved a cross sectional analysis which is far from ideal to explore age versus cohort differences. Still, it is difficult to explain the observed lack of a consistent age gradient in Internet use amongst people over fifty if age itself is an 'endogenous' explanation for the digital divide. Moreover, the failure to reduce the age/cohort effect when health and frailty variables were introduced mitigates against a psychobiological explanation of age/cohorts effects. Interpreting the results within a generational rather than an ageing/stage of life framework seems more coherent and connects better with secular trends in Internet use in the United States where there is recent evidence of a more rapid take up of the Internet by people aged 60 or over (Martin and Robinson 2007). Whilst the posited tendency for people in later life to 'disengage' from wider cultural and social trends might imply a constant digital 'divide', framing the divide in generational rather than stage of life terms would predict a steady diminution of age related differentials in Internet access. Such a perspective implies growing age-group permeability in the use of domestic ICT, with rates of uptake being highest amongst those cohorts with more extensive participation in 'third age' lifestyles. The attenuation of the age/cohort relationship with Internet usage within the more ICT-engaged sample would seem to support this. If such a generational explanation is the case, those now entering retirement may well bridge the current divide. Longitudinal analyses of changing Internet use in the subsequent waves of the ELSA sample will show if this interpretation is correct.

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