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What are the Characteristics of Respondents using Different Devices in Mixed-device Online Surveys? Evidence from Six UK Surveys

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Summary

There is a move towards online data collection across the world. Online survey response is complicated by respondents using different devices. So far, no research has been conducted in the UK to study characteristics of people using different devices in mixed-device online surveys. This analysis uses *all* publicly available UK social surveys with an online component: Understanding Society Innovation Panel, Community Life Survey, European Social Survey, 1958 National Child Development Study and the Second Longitudinal Study of Young People in England. Descriptive analysis and logistic regressions are used to explore significant correlates of device use in online surveys. The results of bivariate analysis suggest that age, gender, marital status, employment, religion, household size, children in household, household income, number of cars and frequency of internet use are significantly associated with device used across surveys. The associations with age, gender, employment status, household size and education are consistent with the findings from other countries. The knowledge about respondents' characteristics using different devices in online surveys in the UK will help to understand better the response process in online surveys and to target certain subgroups more effectively. It is also important for designs of online surveys, understanding of data quality and post-survey adjustments.

Key words: Online surveys; mixed-device online surveys; online completion; device used; mobile devices; smartphones.

1 Introduction

We live in a digital age with a high level use of technologies in everyday life. Surveys have also started to adopt technologies including mobile devices for data collection across

the world. There is a big move in the direction of online surveys in the UK, including the plan to collect 75% of household responses in the UK 2021 Census through online data collection. This trend is motivated by the need to reduce costs of data collection, to increase efficiency and to respond to the advances in communication and technologies in our society today. However, evidence is needed to demonstrate that the online data collection strategy will work in the UK and to understand how to make it work effectively. An intermediate aim is to better understand the response process in online surveys and in particular what groups of the sample members use the different devices for survey completion. This study's main aim is to explore characteristics of people using different devices for online survey completion. We are interested in general findings that hold across surveys and might be generalisable to other contexts where this area is still underresearched and also in findings that may be survey specific.

According to the most recent estimates, the internet was used daily or almost daily by 82% of adults in Great Britain in 2016 (ONS, 2016). In 2016, 89% of households in Great Britain and 77% of households in Northern Ireland had an internet connection (ONS, 2016; Ofcom, 2016). The use of the internet is not homogeneous across all population groups with older people especially single pensioners still not engaging in this digital revolution (ONS, 2016). Smartphones are the most popular devices used by 71% of adults to access the internet in 2016, whereas 62% of adults used laptops or netbooks, 52% tablet computers, 40% desktop computers, 21% smart TV and 18% other mobile devices (ONS, 2016). Smartphones were owned by 71% of the UK adults in 2016, and 4% of UK adults had access to the internet via a smartphone only (Ofcom, 2016). However, it is important to note that among certain groups of the population, the percentage of those accessing the internet via smartphone only will be higher as observed by Lugtig *et al.* (2016) in the US context. Due to the significant increase in the use of different mobile devices including smartphones, it can no longer be expected that all participants would use PCs or laptops in online surveys. According to Peterson *et al.* (2015), Antoun (2015), Antoun et al. (2017), de Bruijne and Wijnant (2014), Revilla *et al.* (2016) and Hanson and Matthews (2016), increase in smartphone use for surveys has already been observed. Historically, smartphones were blocked from social surveys completion as an option for respondents due to the fear of smartphones producing poor quality data as questionnaires look different on smartphones when compared to other devices. Later, some surveys stopped blocking smartphones from survey completion but started discouraging their use due to lack of optimisation of smartphone questionnaires. Currently, this is still the case in a number of the UK social surveys such as the Understanding Society. However, more and more social surveys have moved to 'online first' survey design in which questionnaires are first designed with smartphones in mind. This is a very welcoming development in online surveys due to continuing increase of smartphone ownerships in the UK population.

Unfortunately, not much is known about mixed-device online data collection in the UK and specifically about the use of mobile devices in online survey data collection. This paper aims to study survey participants' use of specific devices to complete a range of online surveys [desktops (PCs), laptops, tablets and smartphones where possible] and the characteristics of sample members who use a specific device for the survey completion. The main research question of the paper is: *What are the differences in characteristics of respondents who use different devices for online survey completion within and across social surveys in the UK?* A key focus is on the effects that can be generalised and are not survey specific. Also, we are able to account for several variables simultaneously by using regressions. In order to address these issues and to enable the analysis, device use paradata (i.e. field process data) (Kreuter, 2013) need be collected and made available to researchers by data collection agencies and research

commissioners. For the surveys used in this paper, we have been able to secure access to these data.

Section 2 of the paper reviews existing literature. Section 3 discusses all the available social surveys in the UK which collected data using online mode of data collection as well as the paradata necessary for the analysis. The results section summarises findings obtained from the analysis of all the available social surveys. The final section compares the results from the UK surveys to other countries. Future work is also discussed, and implications for survey practice are presented.

2 Background and Literature Review

Each new technology provides opportunities for survey research but also introduces new challenges (Couper, 2005). Online surveys provide potential cost savings and might help increase the frequency of interviewing in longitudinal studies, at least for certain subgroups. For example, as younger respondents are more likely to use mobile devices, this might present surveys with an opportunity to reach this potentially harder-to-reach group. Mobile completion, however, was not initially encouraged but rather started in the mid-2000s as a respondent-driven trend that challenged researchers conducting online surveys (Callegaro, 2016). At that time, it was not anticipated that questionnaires would be used on small screens of smartphones, and therefore, questions were not optimised for mobile devices. Similarly, survey software was not prepared to automatically adapt the questionnaires to provide a better experience for respondents. It required a few years for the field to catch up, and many research projects are still devoted to designing effective questionnaires for mixed-device online surveys.

Despite these challenges, the current reality is that 'if you are conducting online surveys, you are conducting mobile surveys' (Link *et al.*, 2014, p. 782). Toepoel and Lugtig (2015) argue that all online surveys should now be treated as mixed-device surveys and emphasise that the current state of knowledge about these surveys is not as advanced as necessary. This suggests that more work needs to be undertaken on device use in mixed-device online surveys.

At the same time, while internet access and smartphone use continues to increase, it is still not universal. Even among web respondents, those who use mobile devices might have different characteristics depending on the specific device they use for survey completion. Therefore, it is important to understand these patterns in online surveys.

Researchers have already started to investigate respondents characteristics in mixed-device online surveys in other countries, including the Netherlands (de Bruijne & Wijnant, 2014; Toepoel & Lugtig, 2014), Germany (Bosnjak *et al.*, 2013), the US (Peterson, 2012) and Spain, Portugal, Argentina, Brazil, Chile, Colombia and Mexico (Revilla *et al.*, 2016). We briefly review this literature, and a summary of their findings is also presented in Table 1. According to Toepoel and Lugtig (2014), age, income, household composition, presence of children and household size were significant predictors of mobile completion, whereas gender, education and urbanisation were not. More specifically, households without children where the woman was older than 50 years old had the lowest likelihood to use a mobile device in the survey in comparison to other groups followed by households without children where the woman was younger than 50 years. The presence of children was therefore found to be a significant predictor of mobile completion. Respondents with a high household income had higher probability to respond via mobile device when compared to those with medium or low income. The larger the number of people in the household, the lower the likelihood of the household respondents to use smartphones for survey completion. Their findings suggested, as would be expected, that young people were more likely to use mobile devices for surveys and showed higher mobile

Table 1. *Summary of associations between different devices used in online survey completion and individual characteristics in different studies.*

Variables/countries	Toepoel and Lugtig (2014)	de Bruijne and Wijnant (2014)	Bosnjak *et al.* (2013)	Revilla *et al.* (2016)	Peterson (2012)
	Netherlands		Germany	Spain (S), Portugal (P), Argentina (A), Brazil (B), Chile (Ch), Colombia (C), Mexico (M)	US
Age	Y	Y	Y	Y (B, Ch, C, S)	Y
Gender	N	Y	N	Y (S, P)	Y
HH composition	Y	Y	-	-	-
HH size	Y	-	-	Y (P, A)	-
HH income	Y	-	-	-	-
Children in HH	Y	-	-	-	-
Employment status	-	Y	-	-	-
Education	N	Y	N	N	-
Ethnicity	-	-	-	-	Y
Urban/rural	N	-	N	-	-

Note: Y means that the variable was available for the analysis and was found to be significantly associated with the device used variables. N means that the variables was available for the analysis but was not found to be significantly associated with the device used variable. '-' means that the variable was not available.

completion rates. de Bruijne and Wijnant (2014) found that there were differences not only between PC and mobile device users but also between tablets and smartphone users. According to their results, tablets were used for survey completion by working adults between 25 and 54 years old whereas smartphones were used by young people (younger than 35). Both device types were used more among female participants for survey completion than among male participants who were more likely to use a PC. They also reported that for tablet users, age, gender, employment status and housing composition were significant predictors whereas only age and education were significant predictors for smartphone use. Those who had paid work and who lived with others were more likely to access the survey using tablets than those who did not work or who live alone. Those who had higher educational qualifications were more likely to use tablets or smartphones than PCs when compared to those with lower education. They also found that usage of mobile devices such as smartphones and tablets was the highest among younger respondents. Bosnjak *et al.* (2013) also reported that younger participants were more likely to use mobile devices. They observed no significant effect of gender, educational level or type of residence on the use of a specific device. Revilla *et al.* (2016) found a significant gender effect in their study only for Spain and Portugal with men having higher probability of using PCs than mobile devices when compared to women. Revilla *et al.* (2016) also reported no significant effect of education on the device used to complete the survey. They found a significant effect of age on use of mobile devices in surveys only in four countries out of seven (Brazil, Chile, Columbia and Spain) with older people being more likely to use PCs than mobile devices. Revilla *et al.* (2016) also reported a significant effect of number of people in the household on the use of a specific device in Portugal and Argentina with respondents from households with more people being less likely to use PCs. Peterson (2012) found that in the US female participants, younger people, people of Black and Hispanic backgrounds and medical specialists were more likely to access surveys on smartphones than on PCs when compared to other groups. All studies discussed earlier which found significant associations between device used and age and between device used and gender observed the same direction of association: younger people, as would be expected, were more likely to use mobile devices, and older people were more likely to use PCs and laptops (Toepoel & Lugtig, 2014; de Bruijne & Wijnant, 2014; Bosnjak *et al.*, 2013; Revilla *et al.*, 2016; Peterson 2012), and female participants were more likely to use mobile devices than male participants (de Bruijne & Wijnant, 2014; Peterson, 2012; Revilla *et al.*, 2016).

However, findings regarding household size and device used reported the opposite direction of association. According to Revilla *et al.* (2016), respondents from larger households were more likely to use mobile devices. These results are in disagreement with the findings reported by Toepoel and Lugtig (2014) who suggested that the larger the household, the lower the likelihood of mobile use for survey completion. Further research is needed in order to obtain more conclusive results.

No studies exist for the UK context, and it is important to explore to what extent the associations are similar or different in the UK when compared to other countries. This study, therefore, is timely and will address this gap in knowledge. The knowledge about characteristics of respondents using different devices in online surveys in the UK will help to understand better the response process in online surveys and to target certain subgroups more effectively. These results will also be important for future designs of online surveys, for understanding of data quality issues and for post-survey adjustments.

The results reported in this paper will be relevant not only for UK surveys but also for non-UK surveys and readers as the associations observed in the UK might hold across other countries where this area is still underresearched. In particular, the results will identify towards

similar associations in different contexts once the cross-country comparison is conducted and the same associations are found to be consistent in different country contexts.

3 Data

This paper uses *all* the social surveys in the UK which used an online mode of data collection and collected the necessary paradata to study characteristics of people who use different devices in online mode of data collection. These surveys are the Understanding Society Innovation Panel Waves 7 (IP7) and 8 (IP8), a UK mixed-mode experiment carried out by the European Social Survey (ESSMM) in 2012, 1958 National Child Development Study (NCDS), Community Life Survey (CLS), and Wave 4 of the Second Longitudinal Study of Young People in England (LSYPE2). These surveys allowed respondents to select the device they used. However, all surveys either discouraged or blocked the use of smartphones. All these surveys including Innovation Panel Waves 7 and 8 are treated as cross-sectional for this analysis. The reason for treating the IP7 and IP8 as cross-sectional is due to the change of protocol regarding smartphone use between Waves 7 and 8. In addition, the Opinions and Lifestyle Survey (OPN) and the Labour Force Survey (LFS) also conducted some experiments in the area of the online mode of data collection in the past, but they have not used this mode of data collection in recent years and did not collect necessary paradata in the past. Therefore they will not be used in the analysis here.

3.1 Understanding Society Innovation Panel

Understanding Society is the Household Longitudinal Study in the UK. The survey covers topics of health, work, education, income, family and social life to help understand the long-term effects of social and economic change, as well as policy interventions. The Understanding Society Innovation Panel is a sample of 1500 households used by researchers as an experimental vehicle for innovative ways of collecting data and for developing new areas of research.

At Waves 5–10, the IP was used to investigate the use of online interviewing. An online option was incorporated into a mixed mode design as a cost reduction and quality improvement initiative. The Wave 5 sample contained original and refreshment components and had two components: face-to-face (one-third of each sample) and mixed mode (two-thirds of each sample). The randomisation was implemented across PSUs to ensure that each sampling point contained a mix of households in each treatment group. At Waves 6–9 households which were not completed at the end of the standard face-to-face fieldwork period were contacted again in a 'mop-up' stage of fieldwork. The face-to-face group was contacted to offer a web interview during the 'mop-up' stage. At Wave 7, the IP7 refreshment sample was not included in the web mop-up. At Wave 8, the IP6 and IP7 'web first' sample remained 'web first'. However, a subgroup of households which was previously allocated to the 'web first' group was deemed to have very low online response propensity and therefore was moved to the 'face-to-face first' group. Online response propensities were calculated for the whole sample and were determined through modelling of observed characteristics, including mode of completion for previous waves. Mode allocation was made in advance of fieldwork at the household level in all waves and subsamples (Jäckle *et al.*, 2018). More details about the data can be found in Jäckle *et al.* (2018).

The first use of online data collection in this survey was in the Innovation Panel Waves 5 and 6 (IP5 and IP6) which collected data through the web for a proportion of the sample as part of a mixed-mode design initiative. However, mobile device paradata were not collected, and

respondents were unable to complete the survey using a smartphone or a small tablet. In IP7 and IP8, however, device paradata are available for researchers. In IP7, all devices with a screen size below 7 inches were automatically blocked from the survey. If a participant tried to access the survey with these devices, they were directed to a message asking them to use a PC, laptop or a larger tablet (Hanson *et al.*, 2015). This restriction was removed for IP8, allowing respondents to complete the survey using the device of their choice. However, respondents were still encouraged in their advance letter to use a PC, laptop or a larger tablet (Hanson *et al.*, 2016).

3.2 European Social Survey

The ESS is a biennial face-to-face cross-national survey of attitudes and behaviour. In total, 36 countries have taken part in at least one round of the ESS. For some time, the ESS has been considering modes of data collection other than face to face. Six ESS studies have been conducted so far testing mixed-mode data collection four of which included a web mode (for details, see Villar & Fitzgerald, 2017). Paradata identifying which device respondents used were available for the mixed-mode study conducted in parallel to Round 6 of the ESS in the UK in 2012 (ESSMM). A random sample of 3000 UK households was selected from an address-based sampling frame and participants were invited via postal letter to complete a one hour long web survey. Completion via smartphones was not available due to the questionnaire length (the questionnaire would take approximately 1 hour to complete) and due to the large number of questions which had 11-point horizontal scales as these questions were not well suited for the small screens of smartphones. Respondents were informed about this in the invitation letter.

3.3 Community Life Survey

The Community Life Survey (CLS) is conducted for the Cabinet Office to track trends and developments in areas that encourage social action and empower communities. It collects data using face-to-face and online approaches. The online approach was used in the 2013–2014 and 2014–2015 rounds of data collection (CLS, 2013–2014; CLS, 2014–2015), alongside a face-to-face survey. In 2013–2014 (quarters 3 and 4), 4685 respondents completed the online questionnaire having been recruited by invitation letters sent in the post. Respondents were discouraged to use smartphones for survey completion. Paradata on device type were collected but are not publicly released data yet, and therefore, this survey is not used for the analysis. In 2014–2015 (quarters 2, 3 and 4), 2222 respondents completed the online questionnaire. These data are not publicly released yet either but were shared by the data collection agency Kantar Public with the authors, with permission of the Cabinet Office.

3.4 1958 National Child Development Study

The National Child Development Study (NCDS) also known as the 1958 Birth Cohort Study follows the lives of over 17 000 people born in England, Scotland and Wales in a single week of 1958. It collects information on physical and educational development, economic circumstances, employment, family life, health behaviour, well-being, social participation and attitudes (http://www.cls.ioe.ac.uk/page.aspx?&sitesectionid=724). This survey is conducted for the Centre for Longitudinal Studies. Participants aged 55 years were followed up in 2013–2014, and the sample size was 9 135 with 5 995 participants responding to the web survey (NCDS, 2013–2014). This survey adopted a sequential mixed-mode design with a CAWI (computer assisted web interview) stage followed by a CATI (computer assisted telephone interview) stage. The survey only included respondents who were 55 years old at the time of the survey so

Table 2. *Social surveys in the UK used for the analysis.*

	IP7**	IP8*	ESSMM**	Community Life Survey (CLS)*	NCDS*	LSYPE2*
Year of surveys	2014	2015	2012	2014–2015 (Q2, Q3 and Q4)	2013–2014	2016
Sample size of online component	761	2 267	589	2 222	5 933	2 887
Used smartphones for survey completion	0.0%	1.5%	0.0%	1.9%	0.5%	22.3%

Note: *Respondents were discouraged from completing this survey using mobile devices.
**All devices with a screen size below 7 inches were automatically blocked from the survey or smartphones were not allowed.

it represents a very specific population in the UK. Because all participants are of the same age, it is not possible to study age differences in their online responses. Paradata on different mobile devices used by participants were collected and are available for the analysis. Respondents were discouraged from using smartphones to complete the survey.

3.5 Second Longitudinal Study of Young People in England

The Second Longitudinal Study of Young People in England (LSYPE2), known as 'Our Future' to respondents, started at the beginning of 2013 and is managed by the Department for Education. This study is built upon the first LSYPE cohort which was funded by the ESRC. The aims of this study are to follow a sample of young people (13–20 years old) through the final years of compulsory education and their transition from compulsory education to other forms of education, training and employment (Backer *et al.*, 2014). Wave 4 of LSYPE2, when respondents were 16–17 years old, has moved to a sequential mixed-mode design which involves first seeking web-based, then telephone and only then face-to-face interviews (Backer *et al.*, 2014). Due to the nature of the survey, all participants are of the same age so again it is not possible to study age differences in their online responses. The data were expected to become publicly available during the summer 2017. However, due to delays, they will now be released only in May 2019. The data collection agency (Kantar Public) has produced descriptive statistics for this analysis, with permission from the Department for Education.

Table 2 summarises details about the datasets used for the analysis.

4 Data Analysis and Methods

The majority of currently available datasets in the UK has very small subsamples for the survey participants who used smartphones during the survey completion process with the exception of the LSYPE2 (Tables 2 and 3). As mentioned in Section 3, in all surveys use of smartphones was either actively discouraged (including LSYPE2) or even blocked by the data collection agencies (IP7 and ESSMM). Some surveys have large enough sample sizes, but data are not publicly released yet (LSYPE2). These limitations make analysis of the group of respondents using smartphones for survey completion impossible and generalisation of findings difficult in some surveys. However, analysis of the existing datasets is useful in describing the patterns in different groups of online respondents in the UK, and it addresses the currently existing gap in knowledge about mixed-device online surveys in the UK. Sample sizes and data availability allow for generalisation of some findings and advanced statistical modelling. In some surveys, we can distinguish between tablets and smartphones (IP8, CLS and LSYPE2) and compare these groups with those using PCs and laptops, whereas in other surveys (IP7, NCDS and ESSMM), we can only study differences between PC and laptop users and mobile device users (in this group the majority of respondents would be using tablets or large phones

Table 3. *Distributions of the two main response variables ('device used') used for the analysis in the different surveys.*

	Main variable 1			Main variable 2	
Survey	PC/laptop	Tablet	Smartphone	PC/laptop	Mobile device
IP7 (%)				621 (81.6)	140 (18.4)
IP8 (%)	2030 (90.3)	184 (8.2)	33 (1.5)		
ESSMM (%)				540 (91.7)	49 (8.3)
CLS 14-15 (%)	1606 (72.5)	567 (25.6)	42 (1.9)		
NCDS (%)				5056 (86.5)	790 (13.5)
LSYPE2 (%)	1737 (60.6)	485 (16.9)	643 (22.5)		

as smartphone use was either blocked or discouraged and therefore represent a non-existent or a small proportion of the respondents).

For some of the surveys such as LSYPE2 and ESSMM, only descriptive statistics (percentages), chi-square statistics adjusted for sample designs and patterns in different device use in mixed-device online surveys the UK are presented. In other surveys (IP7, IP8, CLS and NCDS) where sample sizes within groups of respondents and data availability allow this analysis, we are able to account for several variables simultaneously by using regressions. In these surveys, binary or multinomial logistic regression are also employed for the analysis. The modelling accounts for the clustered sample design by robust standard error estimation and for stratification by including appropriate covariates into the final models. All data analysis was conducted using STATA version 12.

4.1 Dependent Variables

In order to conduct comparison of the devices used across the different surveys, standardised variables for device used by participants were produced for each survey. For the surveys in which smartphones were not blocked, the main variable of interest has three categories (PCs/laptops, tablets and smartphones). For the surveys which did not allow or discouraged smartphone use which resulted in proportions of smartphone use close to 0, the variable of interest reduces to a binary variable which distinguishes between traditional devices (PCs/laptops) and mobile devices such as tablets or large phones. Table 3 presents the distributions of different device use in the UK social surveys included in our analysis. This table shows that most respondents in the ESSMM and NCDS use traditional devices such as PCs and laptops. In LSYPE2, which consists of 16–17 year olds, smartphone use is relatively high when compared to other surveys despite the fact that respondents were advised to use a larger screen device in their survey invitation (Hanson & Matthews, 2016). Smartphone use was blocked or not allowed in the ESSMM and IP7 and actively discouraged in NCDS, IP8, CLS and LSYPE2. Proportions of respondents used smartphones in each survey are reported in Table 2. For IP7, ESSMM and NCDS the main response variable of interest is hence the binary variable which distinguishes between traditional online devices (PCs and laptops) and mobile devices including different tablets and large phones. For the remaining three surveys (IP8, CLS and LSYPE2), the main variable of interest is the three category variable.

Three surveys (IP, ESSMM and CLS) are samples of the UK general population, whereas as mentioned earlier, LSYPE2 consists of a sample of 16–17 year olds, and in the NCDS, all respondents are 55 years old. Due to the specific nature of the last two surveys, it is impossible to study associations between mobile device use and age. However, the first three surveys have samples of younger and older respondents, and their online survey behaviour are of interest as previous studies reported differences in device usage for online survey completion by age in

online survey completion (de Bruijne & Wijnant, 2014; Bosnjak *et al.*, 2013; Peterson, 2012; Toepoel & Lugtig, 2014; Revilla *et al.*, 2016).

4.2 Exploratory Variables

The UK datasets available for analysis contain a wide range of variables. More explanatory variables are available from the rich sources of data for analysis when compared to availability of variables in other countries (Tables 1 and 3). After careful considerations, additional available variables were included for the analysis. We hypothesised that, for example, marital status could be associated with the device used in a similar way as household composition variable studied previously. The tenure or number of cars variables might be association with device used in a similar way as household income variable. Also, the internet use variable might be associated with device used in a way that people with different internet use behaviours might have preferences for devices they use to access internet in general and to respond to surveys in particular. We compare results of our analysis of variables discussed in literature to the previous results. Also, additionally, available variables which belong to the three main groups discussed in the succeeding texts allow us to contribute to literature when their significance of associations with device used variable was assessed. All explanatory variables used for the analysis can be split into three main groups: (a) demographic characteristics, (b) socio-economic characteristics and (c) internet use. The following variables are tested for associations with device used by respondents:

Table 4. *Availability of explanatory variables by surveys and results of chi-square tests adjusted for sample designs.*

	IP7	IP8	ESSMM	CLS	NCDS	LSYPE2
Age	Y*	Y***	Y	Y***	NA (same age)	NA (same age)
Pension age	Y**	Y***	-	-	-	-
Gender	Y*	Y**	Y	Y***	Y***	Y***
Marital status	Y*	Y***	Y	Y***[1]	Y	-
Ethnicity	Y[1]	Y[1]	Y[1]	Y[1]	-	-
Religion	-	-	Y	Y**	-	-
Education/ highest qualification	Y	Y	Y[1]	Y	-	Y***
Employment status	Y	Y**	Y	Y***	Y	Y**
Accommodation type	-	-	-	-	Y	-
Tenure	Y*	Y***	-	Y***	-	-
Household income	Y	Y**	Y	Y***	Y	NA
Number of cars	Y	Y**	-	-	Y	NA
Urban/rural	Y	Y	Y	-	-	-
GOR	Y	Y[1]	Y[1]	-	-	-
Country of residence	Y	Y[1]	Y[1]	-	-	-
Household size	Y	Y[1]	Y	Y*	-	-
Children in household	Y*	Y*	Y	Y***	Y	NA
General health	Y	Y	-	Y	Y	Y
Use of internet or social networking sites	-	-	-	Y	-	Y***
Frequency of internet use	Y	Y***[1]	-	Y**[1]	Y***	-

Note: Y variables are available for analysis; NA - not applicable; chi-square test (device used by explanatory variables): *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

[1]Exact results for the Pearson chi-square test are obtained when more than 20% of cells have expected count less than 5 (not adjusted for sample design, conclusions are the same from chi-square tests adjusted for the designs).

(i) *demographic characteristics*: age, whether of pensionable age, gender, marital status, ethnicity, religion, education, employment status, residence (urban or rural), Government Office Region (GOR), country of residence, household composition, children living in household and general health;
(ii) *socio-economic characteristics*: accommodation type, tenure, household income and number of cars (as a proxy for household income); and
(iii) *internet use*: use of internet/ social networking sites and frequency of internet use.

Not all variables are available in each survey (see Table 4 for the list of variables available across surveys).

5 Results

5.1 Bivariate Analysis

The results of bivariate analysis and chi-square tests of association between the device used and respondent's characteristics are summarised in Table 4, and details can be found in Tables S1–S6. Table S7 presents conditional distributions of the groups which are significantly different from the others with the help of adjusted standardised residuals of chi-square tests. Adjusted standardized residuals have a standard normal distribution with mean of 0 and standard deviation of 1. Therefore, adjusted residual that is larger than 1.96 indicates that the number of cases in that cell is significantly larger than would be expected if the null hypothesis were true with significance level of 0.05. An adjusted residual that is less than -1.96 indicates that the number of cases in that cell is significantly smaller than would be expected if the null hypothesis were true.

The results of bivariate analysis suggest that none of the available variables in ESSMM are significantly associated with the device used for online survey completion. This lack of significance might be related to the low number of respondents in the mobile device group (the tablet group has only 49 respondents), to the fact that smartphones were blocked in this survey and that the total sample size of the web component of the survey is the smallest when compared to other surveys (589 respondents). Therefore, all results below will be presented for the remaining five datasets used for the analysis

The results of the bivariate descriptive analysis suggest that *age* is significantly associated with device used across all surveys where samples represent the general population of adults. In all three datasets (IP7, IP8 and CLS), younger people (under 49) are more likely to use mobile devices whereas older people (49 and above) are more likely to use PCs/laptops. Results from IP8 suggest that younger people (20–39 years old) are substantially more likely to use smartphones when compared to other age groups whereas those who are 40 and older are more likely to use PCs and tablets when compared to smartphones. The same patterns are observed in CLS.

When an indicator variable regarding *pension age* is considered in IP7 and IP8 (the variable is significantly associated with device used by respondents), the results are consistent with the results for the *age* variable reported earlier: those who are of pension age are more likely to use PCs/laptops whereas people who are not of pension age (i.e. younger people) are more likely to use tablets and smartphones. All the results earlier for the UK are consistent with the findings produced for other countries by Toepoel and Lugtig (2014), de Bruijne and Wijnant (2014), Bosnjak *et al.* (2013), Revilla *et al.* (2016) and Peterson (2012).

Gender is also found to be significantly associated with the device used across all surveys. In IP7 and NCDS, male participants are more likely to use PCs/laptops than female

participants whereas the latter are more likely to use tablets than the former. In IP8 and CLS, male participants are more likely to use PCs/laptops than tablets and smartphones whereas female participants are more likely to use tablets and smartphones. In LSYPE2, male participants are more likely to use PCs/laptops and tablets whereas female participants are more likely to use smartphones. All these results have the same direction of association between the two variables and are consistent with the results reported by de Bruijne & Wijnant (2014), Peterson (2012) and Revilla *et al.* (2016).

A *marital status* variable is available in all surveys except LSYPE2 and is found to be significantly associated with device used by respondents in IP7, IP8 and CLS but not significant in NCDS. In IP7, those who are married, separated or divorced are more likely to use PCs/laptops whereas single and widowed people are more likely to use tablets. In IP8, people who are single, separated or divorced are more likely to use smartphones whereas married and widowed people are more likely to use tablets or PCs/laptops. In the CLS, single people are substantially more likely to use smartphones whereas married, divorced or separated are more likely to use PCs/laptops and tablets. As single people are more likely to be younger, the bivariate analysis might be masking an age effect.

Employment status is found to be significantly associated with device used in IP8 and CLS as well as in LSYPE2. Those employed are more likely to use smartphones and tablets for survey completion when compared to PCs/laptops whereas unemployed people are more likely to use PCs/laptops in both IP8 and CLS. The results are consistent with the findings by de Bruijne and Wijnant (2014). For those who have some paid work in LSYPE2, the likelihood of using smartphones is also the highest, whereas those who do not have any paid work are more likely to use PCs/laptops and tablets for survey completion. However, the employment context for the LSYPE2 is different from the other surveys due to the age of participants (16–17 year olds).

An *ethnicity* variable is available in IP7, IP8 and CLS. No significant association is found between the main variable of interest and the ethnicity variable. This association should be explored further in datasets with larger sample sizes to produce more conclusive results.

An *education* variable is available for assessment in IP7, IP8 and CLS, and the association between this variable and device used variable is found not to be significant in all three datasets. The same results were reported by Toepoel and Lugtig (2014), Revilla *et al.* (2016) and Bosnjak *et al.* (2013).

Religion is found to be significantly associated with the use of a specific device in CLS. Those who reported having no religion or a non-Christian religion are more likely to use smartphones whereas those who reported themselves as being Christians are substantially more likely to use PCs/laptops or tablets.

An *accommodation type* variable is available in NCDS but is found not to be significantly associated with device used.

Tenure is significantly associated with the use of a specific device in IP7, IP8 and CLS. In IP7 those who rent their accommodation are more likely to use tablets or large phones than PCs/laptops in comparison to those who are the owners of their accommodations. In IP8 and CLS, those who rent their accommodations are more likely to use smartphones whereas those who own their accommodation are more likely to use PCs/laptops or tablets. The same as marital status variable, tenure variable might be confounded with the age effect in the bivariate context.

A *household income* variable is available in IP7, IP8, CLS and NCDS. This variable is found to be significantly associated with device used by respondents in IP8 and CLS whereas it is not significant in IP7 and NCDS. Those with no income as well as those in the lowest income quartile (1st quartile) are more likely to use smartphone than other devices whereas people in the

2nd and the 3rd quartiles are more likely to use PCs/laptops or tablets in CLS. People on the highest income (from the 4th income quartile) are substantially more likely to use tablets than other devices. In IP8, people on the lowest income (from the 1st income quartile) are more likely to use PCs/laptops, on the medium income (from the 2nd and 3rd quartiles)—smartphones and respondents on the highest income (from the 4th quartile)—tablets in comparison to other devices. According to Toepoel and Lugtig (2014), in the Netherlands, people on a higher income are more likely to use smartphones. The results from the UK are somewhat similar in terms of the general direction of the association but not entirely the same and more research needs to be conducted to obtain more detailed results regarding associations between income and the use of specific devices for survey completion.

A variable *number of cars* is available in IP7, IP8 and NCDS and is significantly associated with device used in IP8 and NCDS. People with no or one car are more likely to use PCs/laptops whereas people with two or more cars are more likely to use tablets. In IP8, people with no cars or one car are also more likely to use PCs/laptops than mobile devices, whereas people with four or more cars are more likely to use tablets and smartphones. This variable might serve as a proxy to a *household income* variable, and the results are consistent between the two variables.

Types and places of residence (*urban/rural*, *country of residence* within the UK and *GOR*) are assessed for significance where available and are found to be not significant. The same results are found for the *general health* variables.

Household composition in the form of number of adults in the household is found to be significant in CLS but not significant in IP7 or IP8. In CLS, households with smaller number of adults (one to three) have higher likelihood of using different mobile devices than households with four or more adults where the likelihood of using PCs/laptops is substantially higher. Toepoel and Lugtig (2014) and Revilla *et al.* (2016) reported the results in relation to household size and their results are not in agreement. Our findings suggest that respondents from larger households are less likely to use PCs/laptops, and these results are consistent with the results reported by Revilla *et al.* (2016) but not with the results obtained by Toepoel and Lugtig (2014). However, the results reported by Toepoel and Lugtig (2014) could have been driven by the fact that in their model the authors used two different variables (one for household composition and one for household size) rather than just for one variable (household size) used in our study and in Revilla *et al.* (2016).

Association between presence of *children in household* and device used can be assessed in NCDS, IP7, IP8 and CLS. The association is significant in IP7, IP8 and CLS but not significant in NCDS. However, in NCDS, this variable has different meaning due to the age of people in the survey (all respondents are 55 years at the time of the survey). Therefore, respondents in NCDS are less likely to have dependent children. In IP7, those people from households with no children are more likely to use PCs/laptops whereas those with children are more likely to use tablets in comparison to other devices. In IP8 and CLS, people who belong to households with no children are more likely to use PCs/laptops whereas those with children are more likely to use tablets and substantially more likely to use smartphones. These results are consistent with findings from the Netherlands reported by Toepoel and Lugtig (2014).

The indicator variable for *use of internet* is available in CLS and LSYPE2, and *frequency of internet use* is available in IP7, IP8, CLS and NCDS. The use of internet or social networking sites variable is found to be nonsignificant in CLS but significant in LSYPE2. In LSYPE2, those who use social networking sites regularly throughout the day are more likely to use smartphone than other devices for survey completion when compared to other groups. Those who use social networking sites once a week or less are more likely to use PCs/laptops for survey completion when compared to other groups. Frequency of internet use is found to be significant in IP8, CLS and NCDS with those using internet very or rather frequently are more likely to use mobile

devices for the survey whereas those who use internet rarely are more likely to use PCs/laptops. This variable is not found to be significant in IP7.

5.2 Binary and Multinomial Logistic Regressions

Binary logistic regressions are fitted to NCDS and IP7 data, and multinomial logistic regressions are fitted to CLS and IP8 data. Unfortunately, due to lack of direct access to the LSYPE2 data, modelling of these data is not possible at this stage. The results from binary logistic regressions can be found in Table 5 and from multinomial logistic regressions in Table 6.

Gender, marital status and tenure are found to be significantly associated with device use in IP7 whereas age, children in household, pension age and employment status are found not to be significant. Females are more likely to use tablets than PCs/laptops for the survey when compared to males. Those respondents who are widowed are significantly more likely to use tablets than PCs/laptops when compared to single people but the magnitude of the effect should be treated with caution due to the small group of those widowed in this datafile ($n = 23$). Those in privately rented accommodation are also more likely to use tablets than PCs/laptops when compared to those living in owned accommodation. No significant interactions are found in this model. In this survey, smartphones were blocked which might explain why the age variable is not significant.

Table 5. *Results of binary logistic regressions (NCDS and IP7).*

	IP7 (1- mobile device)[1] ($N = 5\,844$)		NCDS (1-mobile device) ($N = 695$)	
	LOR	Robust SE	LOR	Robust SE
Intercept	−1.912***	0.240	−2.036***	0.064
Gender				
Male (ref)				
Female	0.515*	0.207	0.498***	0.084
Marital status			NS	
Single (ref)				
Married	−0.086	0.235		
Separated or divorced	−0.145	0.374		
Widowed	1.341**	0.455		
Tenure			NA	
Owned outright or with mortgage (ref)				
Rented from LA or HA	0.421	0.319		
Rented privately or from employer	0.870*	0.341		
Frequency of internet use	NS			
Everyday or almost everyday (ref)				
Several times a week			−0.052	0.214
Once or twice a week			−0.203	0.299
At least once a month			−0.694	0.599
Less often or never			−0.225	0.474
Interaction: gender*frequency of internet use	NS			
Male*everyday or almost everyday (ref)				
Female*several times a week			−0.698*	0.290
Female*once or twice a week			−1.356**	0.491
Female*at least once a month			−0.492	0.793
Female*less often or never			−0.108	0.569

Note: Log odds ratios (LOR) and robust standard errors of the binary logistic regression model predicting using mobile devices (tablets and large phones). NA - not applicable; NS - not significant variable.
[1]No significant interactions.

Table 6. *Results of multinomial logistic regressions (IP8 and CLS).*

	IP8[1] (N=2 214)		CLS[2] (N=2 125)	
	Tablet LOR (RSE)	Smartphone LOR (RSE)	Tablet LOR (RSE)	Smartphone LOR (RSE)
Intercept	2.834 (0.244)***	−4.709 (0.638)***	−1.461 (0.205)***	4.981 (1.109)***
Gender				
Male (ref)				
Female	0.500 (0.163)**	0.549 (0.402)	0.539 (0.105)***	0.031 (0.335)
Employment status				
Not employed (ref)				
Employed	0.355 (0.185)	0.820 (0.408)*	0.378 (0.135)**	0.580 (0.482)
Household Income			NS	
1st quartile	−0.691 (0.247)**	0.003 (0.698)		
2nd quartile	−0.594 (0.222)**	0.817 (0.56)		
3rd quartile	−0.557 (0.211)**	0.679 (0.557)		
4th quartile (ref)				
Age	NS			
16–19			−0.278 (0.315)	1.384 (1.299)
20–29			−0.424 (0.248)	2.266 (1.121)*
30–39			0.048 (0.24)	1.553 (1.224)
40–49			0.142 (0.237)	0.411 (1.349)
50–59			−0.008 (0.225)	0.714 (1.249)
60–69			0.155 (0.201)	0.659 (1.156)
70+ (ref)				
Children in household	NS			
No			−0.846 (0.127)***	−0.882 (0.414)*
Yes (ref)				

Note: Log odds ratios (LOR) and robust standard errors (RSE) of the multinomial logistic regression model predicting using tablets and smartphones (PC is the reference category). NS - not significant variable.
[1]No significant interactions in the model.
[2]No significant interactions in the model.

Gender and frequency of internet use as well as the interaction between these two effects are found to be significantly associated with device used in NCDS whereas number of cars is found to be nonsignificant. Figure 1 shows predicted probabilities of using tablets by gender and frequency of internet use in the NCDS survey.

Figure 1 shows that the probabilities of using tablets in comparison to PCs/laptops are not very high (between 0.04 and 0.17). Those who use the internet every day or almost every day have the highest probability of using tablets in comparison to those who use the internet less frequently or not at all. Interestingly, the probability of using a tablet for the survey completion is also higher for those who use the internet either very rarely or never. Female participants who use the internet very frequently or not at all have higher probability of using tablets when compared to male participants in the same internet use groups.

Age, gender, employment status and children in household are found to be significant in CLS whereas number of adults in the household, household income, tenure, religion and marital status are not found to be significantly associated with the main variable of interest. Female participants are significantly more likely to use tablets than PCs/laptops when compared to males. Those living in households without children are less likely to use tablets or smartphones in comparison to those from households with children. Employed people are more likely to use tablets than PCs/laptops for survey completion when compared to the unemployed; 20–29 year olds are more likely to use smartphones than PCs/laptops when compared to 70 year olds and above. Also, those who are 20–29 year olds are more likely to use smartphones than tablets in

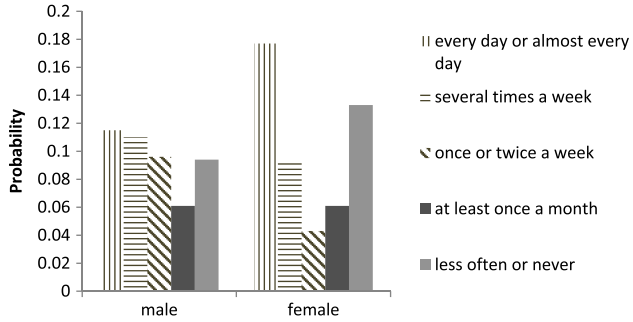

Figure 1. *Results of logistic regression modelling (NCDS): probability of using tablet by gender and frequency of internet use (N=5 933).*

comparison to those who are 70 years old or older. No significant interactions are found in this model.

Gender, employment status and household income variables are found to be significantly associated with the main variable of interest in IP8 whereas number of children and number of cars in household variables are not significant in the multinomial logistic regression model. Women are significantly more likely to use tablets than PCs/laptops when compared to men. Employed people are more likely to use tablets and smartphones than PCs/laptops when compared to those unemployed. Those in lower income quartiles (1st quartile) are significantly less likely to use tablets than PCs/laptops for survey completion when compared to those in the highest income quartile (4th quartile). Also, when tablet users are compared to smartphone users, those in 2nd and 3rd income quartile are significantly more likely to use smartphone than tablet in comparison to those in the highest income quartile. No interactions are found to be significant in this model.

The results from all four regression models suggest that even after controlling for other variables, female participants are consistently and significantly more likely to use tablets and smartphones than PCs/laptops when compared to male participants who are more likely to use PCs/laptops for survey completion. However, it should be noted that in NCDS this relationship is only observed for those who use the internet either very frequently and for those who never use the internet. Two multinomial logistic regression models suggest that employment status is significantly associated with device used, and those who are employed are significantly more likely to use tablets than PCs/laptops for survey completion. Other variables which are found to be significantly associated with the device used in different surveys in regression context after controlling for other factors are age, tenure, marital status, household income, presence of children in household and frequency of internet use.

6 Discussion and Conclusions

We live in a digital age with a high level use of technologies in everyday life. Surveys have also started to adopt technologies including mobile devices for data collection across the world. In the UK, there is a big move in the direction of online data collection in social surveys as well as for Census 2021. However, not much is known about mixed-device online surveys in the UK yet. As an intermediate aim, it is necessary to better understand the correlates of different devices in online survey response. This paper fills this gap and explores the characteristics of people who use different devices in online data collection within and across five social surveys in the UK: Innovation Panel of Understanding Society, ESS, CLS 2014–2015, 1958 NCDS,

and Second Longitudinal Study of Young People in England. The different social surveys in the UK and the wide range of explanatory variables available allow for assessment of association between a wider range of variables and device used for survey completion when compared to other countries where similar research was undertaken.

The results from the bivariate analysis found the following variables to be significantly associated with device used across the different social surveys in the UK: age of respondent, gender, marital status, employment status, religion, household composition/size, children in household, household income, number of cars and frequency of internet use.

In the following, the most important findings for survey practice are summarised:

(i) The results regarding age of respondents are consistent with all other studies which explored characteristics of people by device used in different countries with younger people being more likely to use mobile devices and older people being more likely to use PCs/laptops for survey completion (Toepoel & Lugtig, 2014; de Bruijne & Wijnant, 2014; Bosnjak *et al.*, 2013; Revilla *et al.*, 2016 and Peterson, 2012). The initial results from the Understanding Society main survey Wave 8 support the results reported by this study (Hanson, 2016). Age is significant in CLS even after we control for gender, employment status and number of children in household. However, it is not significant in IP7 when we control for marital status and tenure. This might be explained by the fact that those who are single and rent their accommodation are more likely to be younger.

(ii) The results for device used by gender are also consistent with findings from different countries with female participants being more likely to use mobile devices in comparison to other devices than male participants for survey completion (de Bruijne & Wijnant, 2014; Peterson, 2012 and Revilla *et al.*, 2016). This variable is significant in all four regressions (IP7, IP8, NCDS and CLS) even after we control for other characteristics.

(iii) Employed respondents are more likely to use smartphones and tablets than PCs/laptops whereas unemployed people are more likely to use PCs/laptops for survey completion. The results are consistent with the findings reported by de Bruijne & Wijnant (2014). This variable remains significant in IP8 after controlling for gender and household income and in CLS after controlling for gender, age and presence of children in a household.

(iv) A significant association is found between household income and device used. According to Toepoel and Lugtig (2014), in the Netherlands, people with higher income are more likely to use smartphones. The results from the UK are in the same in direction of the association but more research needs to be conducted to obtain more detailed results regarding this association. This variable is still significant after we control for gender and employment status in IP8.

(v) Our findings suggest that respondents from larger households are less likely to use PCs/laptops for survey completion, and these results are consistent with the results reported by Revilla *et al.* (2016). However, these results are in disagreement with the findings reported by Toepoel and Lugtig (2014) who found that the larger the household the lower the likelihood of mobile use for survey completion. The results by Toepoel and Lugtig (2014) should be interpreted with caution as in their model they used two variables (one for household composition and another one for household size) as explanatory variables rather than just one variable for household size. This combination of the two variables might reverse the effect of the household size variable observed in their model. In our analysis, this variable was only significant in CLS. However, once we controlled for age, gender, presence of children and employment status, this variable became nonsignificant.

(vi) The results for presence of children in a household and the device used for survey completion are in agreement with findings from the Netherlands (Toepoel & Lugtig, 2014).

Respondents from the households with children are more likely to use smartphones for survey completion. This variable remains significant in regression context when the model also includes gender, employment status and age variables in CLS. However, this variable is no longer significant in regressions in IP7 and IP8 after controlling for other characteristics.

(vii) Education was found not to be significant in all three datasets where the variable was available (in LSYPE2 the meaning of the education variable is different to other surveys due to the age of the participants). The same results were reported by Toepoel and Lugtig (2014), Revilla *et al.* (2016) and Bosnjak *et al.* (2013).

(viii) Similarities observed in the UK and other counties provide evidence that our results might be generalisable to contexts in which this area is still underresearched.

This study benefits from additional variables that analyses in other countries could not take account of. Apart from the variables discussed earlier, three more variables are found to be significant in the regressions for the different social surveys in the UK: marital status, tenure and frequency of internet use.

(ix) Regression analysis using IP7 suggests that those respondents who are widowed are significantly more likely to use tablets than PCs/laptops for survey completion when compared to single people even after controlling for gender and tenure. This variable is no longer significant in CLS and IP8 when other variables are included into the models.

(x) Those in privately rented accommodations are also more likely to use tablets than PCs/laptops when compared to those living in owned accommodation. This association remains significant in IP7 after we control for gender and marital status. It is not significant in the regression context in CLS after we control for other characteristics of respondents.

(xi) Those respondents who are using the internet every day are more likely to use tablets than PCs/laptops when compared to those using the internet less frequently. The association remains significant after we control for gender in NCDS.

The results presented earlier are the first available findings in the area of mixed-device online surveys for the UK. The findings presented here are important for survey practice, instrumental in better understanding the patterns in different device use in online surveys in the UK and specifically in preparation for the UK 2021 Census in which a target of 75% of household to complete the Census online has been set. A better understanding of response patterns is an intermediate aim that is necessary for further methodological work in this area. These results are important for future designs of online surveys, for understanding of data quality issues and for post-survey adjustments. It is important to mention and investigate in future studies other possible consequences of the use of different devices in mixed-device online surveys such as device effects affecting data quality of online surveys. There is a chance that when questionnaires are not optimised for smartphones, the data quality of responses provided by smartphones users might be poorer than data quality obtained through other devices. Data quality in mixed-device online surveys in the UK should be investigated as soon as large enough surveys are available for the analysis. The results from this work may help targeting of certain groups more efficiently for survey participation. For example, we have seen a clear tendency for younger people and those with very regular use of the internet to use smartphones to complete the surveys. If a survey is conducted among a group that is more likely to use mobile devices, the emphasis in advance communications that the survey can be completed on a smartphone or tablet, and that the survey is optimised for these devices, may help to improve overall response rates. Not allowing smartphones or discouraging their use may impact on participation of younger people and those actively using the internet disproportionately more. Therefore, if smartphones are discouraged, younger people may need additional targeting.

The main limitations of the analysis are small sizes of some groups in some of the surveys analysed. The use of smartphones for survey completion was either blocked or actively discouraged which resulted in small or non-existent groups of smartphone users across surveys with some exceptions such as LSYPE2. However, in the era of high prevalence of smartphone use in the UK, it is difficult to expect that all participants will still be using PCs/laptops for online surveys. According to Hanson and Matthews (2016), there is a risk that respondents will opt not to take part in the survey or will drop out midway through the survey if smartphones are blocked or if surveys are not optimised for different mobile devices. Another limitation of the study is the lack of access to some datasets (e.g. CLS 2013–2014) with the paradata about mobile devices which would allow us to answer the main research question. Absence of direct access to the data (e.g. LSYPE2) which would allow for harmonisation of analysis with other datasets as well as advanced statistical analysis represent yet another limitation of this study. However, despite these limitations, these results are very important as they present the first evidence in the area of knowledge about different device use for mixed-device online surveys in the UK.

Running a cross-survey model (combining all surveys into one dataset) was considered to better understand within and across survey effects, but it was not possible due to peculiarities of some surveys such as NCDS and LSYPE2 in which all participants are of the same age. Another reason is that different surveys had different sets of variables available for the analysis.

It is important to mention that some surveys are now a few years old (Table 2) and do not fully reflect current use of devices, but these data are the best available in the UK for this analysis. It may be advisable to repeat some of the analysis when more recent data become available.

An issue of a choice of device for survey completion is important for this area too. In order to address the issue of device choice, the information about device options available to respondents should be available (but currently is not in the majority of social surveys in the UK). The availability of these data and the possibility of conditioning on the options of devices the respondents had access to would help in interpreting the results obtained by the models in more detail. IP8 started collecting these data, but this information was only available for 753 respondents out of 2247 and therefore was not considered in this analysis. Other datasets used for the analysis do not have information on the options available to the respondents. It is important to address this issue as although respondents use a particular device to answer the survey; they may not be able to choose from all possible devices

Analyses of device use across waves of a longitudinal study and characteristics of respondents associated with the changes of devices across waves as well as the association of the device respondents used and the number of waves they responded to previously are also of importance in a longitudinal context. This analysis will be possible using the soon to be available Understanding Society data.

It is also important to start moving beyond investigations of associations towards a better understanding of why those associations arise. We will address this by investigating time of the day and day of the week paradata which will be available in Wave 8 of the Understanding Society data to address the contexts in which respondents complete surveys further. Access to paradata would allow understanding whether specific types of devices are used by respondents in a home environment or outside of home or work environments. Further investigations of household compositions and use of device for survey completion will also be conducted.

The limitations of this analysis suggest that there is an urgent need to collect large enough samples of online components in social surveys in order to address selection and data quality issues in mixed-device online surveys. Wave 8 of the Understanding Society main survey which will be released in December 2018 will contain a large enough sample and appropriate design for assessment of selection and data quality issues between face-to-face and online modes of data collection. Furthermore, device use paradata need to be routinely collected by

data collection agencies and made available to interested researchers. Unfortunately, currently device use paradata are not routinely released publicly to independent researchers which makes the analysis difficult or impossible. More research is needed in the field of mixed-device online surveys in order to better understand respondents' online survey behaviour in the UK and other countries and in order to develop a more systematic and standardised framework for collection, use and evaluation of mixed-device online survey data. It is clear that smartphones and tablets are now widely used for survey completion, as well as PCs/laptops. Therefore, it is crucial that all surveys are accessible across all devices and designed with this range of devices in mind.

Data Statement

This study uses the following datasets: the Understanding Society Innovation Panel Waves 7 (IP7) and 8 (IP8), a UK mixed-mode experiment carried out by the European Social Survey (ESSMM) in 2012, 1958 National Child Development Study (NCDS), Community Life Survey (CLS), and Wave 4 of the Second Longitudinal Study of Young People in England (LSYPE2). The Understanding Society data, NCDS and CLS were obtained from the UK Data Archive (http://www.data-archive.ac.uk/). Data Citation for the Understanding Society data: University of Essex, Institute for Social and Economic Research. (2018). Understanding Society: Innovation Panel, Waves 1-10, 2008-2017. 9th Edition. UK Data Service. SN:6849, http://doi.org/10.5255/UKDA-SN-6849-10. Data Citation for NCDS data: University of London, Institute of Education, Centre for Longitudinal Studies. (2009). National Child Development Study: Biomedical Data, 2002-2004: Special Licence Access. UK Data Service. SN: 5594, http://doi.org/10.5255/UKDA-SN-5594-2. Data Citation for CLS data: Cabinet Office. (2015). Community Life Survey, 2014-2015. UK Data Service. SN: 7836, http://doi.org/10.5255/UKDA-SN-7836-1. The access to ESSMM dataset was enabled through the European Social Survey (www.europeansocialsurvey.org/data/). LSYPE2 Wave 4 data are not publically released yet and were analysed by Emily Bell from Kantar Public.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.