EARLY MOBILE PHONE OWNERSHIP: INFLUENCING THE WELLBEING OF GIRLS AND BOYS IN IRELAND?

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Abstract

Children live in a technology-mediated world, and most young people use a variety of technologies in their daily lives. However, despite intense public discourse, we have little empirical evidence on how technology use impacts on children's development across a number of psycho-social domains. Research that has been conducted tends to be largely small-scale or cross-sectional in nature and most often focused on (young) adults rather than children. Using longitudinal data on one-in-eight Irish children, we use econometric methods to test for associations between early mobile phone ownership and two measures of children's psycho-social development between 9 and 13 years of age. We examine the Piers Harris Self-Concept Scale, reported by children, and the Strengths and Difficulties (SDQ) score, completed by the primary caregiver. We find no generalised associations between early mobile phone ownership and psycho-social outcomes. However, there is evidence that associations differ by gender and across psycho-social sub-domains. We find no robust associations affecting boys, but girls who receive phones earlier fare less well in terms of their behavioural adjustment and academic self-concept scores at 13 years of age, all else being equal. Further research is needed to identify causal mechanisms and explore possible mediating effects of family/social context.

Keywords: mobile phone ownership, psychological adjustment, self-concept, gender, longitudinal data, Piers Harris, SDQ

Introduction

Today's children are growing up as part of a mobile generation (Lauricella, 2015) and are in constant communication with their peers, creating new standards of behaviour and communication. In Ireland, as elsewhere, mobile phone ownership has soared; 40 per cent of 9 to 16 year olds own a smartphone and an additional 27 per cent own phones that do not have smartphone capabilities (O'Neill & Dinh, 2015). In many ways, engagement with screen media and interactive technology can be classified as dominant childhood activities for many children around the world (Wartella et al., 2016). While digital technologies are constantly advancing, research on their impact on users has lagged. Using nationally representative longitudinal data from Growing Up in Ireland (GUI), this study examines the extent of early mobile phone ownership and its association with the psycho-social development of children as they move into adolescence. Two distinct dimensions are examined: children's self-concept scores, as measured by the Piers Harris Self-Concept Scale, and a measure of their psychological adjustment, as measured by the Strengths and Difficulties Questionnaire, completed by parents (details provided in the Materials and Methods section).

The potential for digital technologies to enhance student learning, within and outside the classroom, has been shown both in the Irish context (McCoy, Lyons, Coyne & Darmody, 2016) and beyond (Balanskat, 2007). International research acknowledges that the mobile phone, in particular, is a potential resource for pedagogical work in the school and classroom (Wishart, 2018; Gao, Yan, Wei, Liang & Mo., 2017). Studies report advantages of using mobile media and technologies for school-aged young people across a host of areas, such as for vocabulary learning (Lu, 2008), second language learning (Thornton & Houser, 2005) and classroom management (Wang, Shen, Novak & Pan, 2009). The Global Kids Online study shows that using technology like mobile phones can improve digital skills, skills which will be essential to negotiate life and work in a fast-changing world (Global Kids Online, 2019).

Given that the age at which children receive phones is increasingly younger (Mascheroni & Cuman, 2014), along with rapid advancement in the nature and ubiquity of this technology, it is important to ask whether such early ownership may be affecting children's psycho-social wellbeing. In many ways, mobile phone technology has the potential to have a distinct impact on the behaviour and development of children. By their nature, mobile phones can play a central role in the behaviour, thoughts, and attitudes of children across the many settings in which they engage (family, home, school, leisure etc.), making monitoring and supervision of usage difficult for parents (and teachers). Children are likely to use mobile phones more frequently than other digital technologies (Rideout, 2013; Lauricella, 2015; Beyens & Valkenburg, 2018), and while each usage might be of shorter duration, the easy access to mobile phones may create a particular relationship in terms of children's psycho-social development. We use data on one-in-eight Irish children to test four hypotheses about possible associations between early mobile phone ownership and measures of children's psycho-social development between 9 and 13 years of age. We test whether there are measurable generalised associations between mobile phone ownership and psycho-social metrics, whether such associations are consistent across sub-domains and whether they arise similarly for boys and girls. A novel feature of the work is the use of a large sample of longitudinal data on individual children, which allows us to control for the effects of many characteristics of children as well as unobserved individual-level characteristics that do not vary over time.

Previous Research: Mobile Phones and Child Development

A growing body of research has been examining how technology-related habits may impact the psycho-social wellbeing of individuals, particularly (young) adults, with relatively little focus on children. However, it is clear that a minority of studies systematically examine the relationships and fewer still draw on robust longitudinal data. A number of studies examine

the link between the use of digital technology and the development of individuals' social competencies and emotion reading. The potential for the disruption of in-person social dynamics has been raised, initially described as "absent presence" or the act of being physically present but having one's mind elsewhere based on communications or content from a mobile phone (Gergen, 2002), followed by descriptions of new social norms leading to the "invasion" of portable devices into personal spaces (Campbell & Park, 2008). More recently, McDaniel and Radesky (2017) examined the associations between greater digital technology use and potential relationship dysfunction or changes in interpersonal interactions. A number of other studies examine aspects of life satisfaction and wellbeing and consider whether this is related to mobile phone use (e.g. Lepp, Barkley & Karpinski, 2014). Their findings suggest that some mobile phone owners may experience anxiety because of a perceived and perhaps overwhelming obligation to remain constantly connected to various social networks through their phones.

The issue of mobile phone "addiction", where the use of technology becomes excessive and "out of control", has been a key focus of the literature in recent years (Volkmer & Lermer, 2019). Coyne, Stockdale and Summers (2019) suggest that for a small group phone use becomes problematic or addictive, characterised by excessive time spent on the phone, interference with social relationships, and difficulty disengaging from the phone. Younger teenagers may be at higher risk of technology and mobile phone addiction (De-Sola Gutiérrez, Fonseca & Rubio, 2016; Lopez-Fernandez et al., 2014). Research has shown excessive use of mobile phones leading to the development of symptoms related to dependence syndrome (Chóliz, 2012; Goswami & Singh, 2016). Turkle (2016) identified risks to socio-emotional development stemming from (excessive) smartphone use, while Coyne, Stockdale and Summers (2019) found that early problematic mobile phone use predicted later depression, but had no association with later anxiety or self-regulation. Woods

and Scott (2016) found that adolescents with heavier social media usage and those more emotionally invested in social media experience poorer sleep quality, lower self-esteem, and higher levels of anxiety and depression. In contrast, Nikolopoulou and Gialamas (2018), in their study of 12-18 year olds, found little self-perceived mobile phone dependence, but the study did find that attitudes of students indicated some symptoms relating to negative life consequences, such as loss of control, withdrawal and using mobile phones to feel better, for example, to escape from unwanted emotions. More generally, experts note that adolescence is a period of greater vulnerability for the onset of depression and anxiety (McLaughlin & King, 2015), so excessive use of digital technologies like mobile phones and social media may have greater impact at this life stage.

A second theme in recent research is that of the impact of mobile phones on the nature of interactions among people. Research finds that young people use social media because these outlets serve as cultural tools that can help scaffold development by providing a platform for youth to engage safely in identity exploration, friendship building and maintenance, and intimacy creation – all goals of adolescent development (Wartella et al., 2016; Erikson, 1968). In a review of the literature, George and Odgers (2015) suggest that time spent online appears to displace in-person interactions. However, they note that there is little evidence that it reduces friendship quality or leads to social isolation. Uhls et al. (2014) found that increasing opportunities for face-to-face interaction while eliminating the use of screen-based media and communication tools improved non-verbal emotion-cue recognition in preteens in the US. However, as George and Odgers (2015) noted, nearly all of the research in this field has relied on self-report data and cross-sectional study designs, making it difficult to discern whether technology usage *per se* is influencing outcomes.

Taking an in-depth qualitative approach, Levine and Stekel (2016) found that technology is not inevitably a source of significant conflict during adolescent years and her

research shows examples of secure attachments with friends that were conducted wholly or almost wholly in technology-mediated ways. Walsh, White and Young (2008) also concluded from their research "a strong theme was that the mobile phone was a tool which facilitated young people's connectedness to others" (p.89). Crucially, these studies illustrate that young adolescents are not passive consumers but rather exercise autonomy and agency in their use of digital technologies like mobile phones in supporting their connectedness to the world around them.

Levine and Stekel (2016) examined experiences for adolescent girls, revealing patterns that may not extend to adolescent boys. Few studies consider if the extent and nature of mobile phone access differs for boys and girls and, crucially, whether such access shapes the socio-emotional development of boys and girls in different ways. There is tentative evidence that girls and boys use their mobile phones in different ways. Girls are more likely to use it primarily as a tool for communication and maintenance of peer groups; boys use it more for its own sake, exploring its features, and as a toy (Lobert-Maris & Henin, 2002; Skog, 2002; Goswami & Singh, 2016). Social media profiles have also been shown to be strongly gender differentiated (Mascheroni & Olafsson, 2013). Nikolopoulou and Gialamas (2018) found higher mobile phone dependence among 12-18 year old girls compared to boys and the impact of excessive or problematic phone usage on wellbeing may also differ for boys and girls (Thomée, Härenstam & Hagberg, 2011). Most generally, McDool et al. (2020) found that internet usage is negatively associated with children's wellbeing across a number of domains, and the effects are worse for girls than boys.

Theoretical Framework

This paper is underpinned by the bioecological model developed by Bronfenbrenner (Bronfenbrenner, 1989; Bronfenbrenner & Morris, 2006), which emphasises children's

connectedness to the world within which they live. It also highlights the importance of considering the multifaceted nature of the influences on development over the life-course. Within this model, the child's development is shaped by the 'microsystem' (family members); the 'exosystem' (structures, institutions and settings which, whilst not in direct contact with children, exert an important influence upon their quality of life and outcomes); and the 'macrosystem' which consists of the culture-specific ideologies, attitudes and beliefs that shape the society's structures and practices, and key economic and political systems. The 'mesosystem' comprises interactions between those systems, such as how families interact with schools or how parents' worklife impacts on their parenting (Williams, et al., 2009). As children move into adolescence, the microsystem is likely to be expanding as children's interactions extend beyond the family and towards peers and classmates, and perhaps also towards social media and online profiles/identities. The influences from the macrolevel will also likely change as the second-level education system will have greater influence and cultural and normative influences around modes of communication and the online world are also shaping adolescents' lives. Whether children own mobile phones or have alternative mechanisms of online access is likely to shape both opportunities to communicate in this way and to create individual digital/online profiles. While the influences evolve as children develop into adolescence, the Bronfenbrenner model also recognises the importance of individual agency. Adolescents may illustrate such agency through the extent of work ethic in their schoolwork, in the way in which they develop their own identity (and online presence), and in how they connect and communicate with others, all of which may have been shaped by earlier influences like parenting style, home environment, peer influences and early school experiences. Hence, children who receive mobile phones at a young age may behave in different ways depending on these earlier influences, as well as the rules parents impose concerning such technology usage.

O'Neill (2015) also takes an 'ecological' approach to understanding children's engagement with technology and the online world, framing the media environment as a complex interplay between technology and society in which modes of communication and mediated interaction fundamentally shape human behaviour and social life (p.2). However, Plowman (2016) usefully points out that 'ecological' frameworks were not designed to focus on technology/media and recent changes in the visibility and omnipresence of technology mean that we need to move beyond a 'flat' representation of ecology, to a more fluid, emergent and multiscalar understanding of context without boundaries (p.190/191). Taking such a 'fluid' bioecological perspective on the contexts within which children develop, we examine whether early access to mobile phone technology plays a role in children's development, perhaps shaping children's relationships with others, how they spend their time or how they engage with the multifaceted systems within which they live. Any changes in these core aspects of children's lives, may shape aspects of their psycho-social development, which may manifest in how they view themselves, or how significant others view their wellbeing. These processes may also vary for boys and girls. Research has shown that boys and girls engage with phone technology in different ways (Lobert-Maris & Henin, 2002; Skog, 2002; Goswami & Singh, 2016). Earlier work has also suggested that girls may be more vulnerable in the risk of internalising behaviours like anxiety and a negative self-concept in childhood and early adolescence, so perhaps early access to mobile phone technology impacts differently for boys and girls (McLaughlin & King, 2015; Frawley. McCoy & Thornton, 2014).

Placing our paper within this framework, we consider whether children who own mobile phones in mid-childhood have systematically better or worse self-concept as they move into adolescence. While early mobile phone ownership may create greater, or different, opportunities for peer interaction, perhaps also it is creating greater opportunities for peer

comparison or reference group effects. Expanding beyond the child's own self-concept, we then consider whether any influence of mobile phones extends to how other people (parents) assess their child's psycho-social wellbeing. This will go some way towards assessing how strong or pervasive any influences on wellbeing are. Based on past theoretical and empirical research, we test four hypotheses:

Hypothesis 1: Early mobile phone ownership is associated with how young people's self-concept develops between 9 and 13 years of age;

Hypothesis 2: Early mobile phone ownership is associated with how young people's psychological adjustment develops as they move into adolescence;

Hypothesis 3: Early mobile phone ownership has broadly similar associations across a range of psycho-social domains, as perceived by children and their parents; and

Hypothesis 4: Boys and girls show different associations between early phone ownership and their psycho-social development.

Materials and Methods

Data

Data from Growing Up in Ireland (GUI), a nationally representative longitudinal study of one-in-eight children residing in Ireland, provides a valuable opportunity to assess the relationship between early phone ownership and dimensions of child development. The study comprised 8,568 nine-year-old children, born in 1997/1998, who were first interviewed between August 2007 and May 2008. The second wave, taking place in 2011 and 2012, comprised 7,525 children at 13 years of age (Quail, Williams, Thornton & Murray, 2014). In the Limitations section at the end of the paper we consider how attrition between waves might affect our results. Reflecting the bioecological model underpinning the GUI study, data

are collected from multiple informants, including children themselves, their parents, and teachers (Greene et al., 2010; Williams et al., 2009; Dempsey, Lyons & McCoy, 2018).

Outcome variables: measuring psycho-social wellbeing

As noted earlier, psycho-social wellbeing is examined using two distinct and widely-used measures, the first reported by children themselves and the second by their parents. The first measure draws on the well-established *Piers Harris Self-Concept Scale* (Piers, Harris, & Herzberg, 2007). The scale is a multidimensional construct containing six sub-scales, including freedom from anxiety, behavioural adjustment, and popularity. The Piers-Harris measure is argued to be ”one of the best if not the best questionnaire of its type” (Kelley, 2004) and has been used in a wide range of settings. We examine the total scale and each of the sub-scales, as several studies have highlighted important differences across different sub-groups (such as gender, age, and special educational needs status) can be masked by focusing on the global self-concept scale (Lewis & Knight, 2007). The sub-scales measure behavioural adjustment, intellectual and school status, physical appearance, freedom from anxiety, popularity, and happiness and satisfaction.

Behavioural Adjustment: This measures admission or denial of problematic behaviours in home and school settings. A score in the very low range means that the child endorses negative feeling about his/her behaviour.

Intellectual and School Status: Measures a child’s self-assessment of intellectual abilities and academic performance. The items also cover general satisfaction with school and future expectations about achievement.

Physical Appearance: Measures a child’s assessment of his or her own physical appearance as well as their appraisals of certain personality attributes such as ability to express one’s ideas and leadership abilities.

Freedom from Anxiety: This scale assesses anxiety and dysphoric mood. Individual items tap a variety of specific emotions, including worry, nervousness, shyness, sadness, and fear.

Popularity: This scale captures the child's evaluation of his or her own social functioning.

Happiness and Satisfaction: This measures a child's feelings of happiness and satisfaction with life.

These measures have provided useful insights into child psycho-social wellbeing in the Irish context (Frawley, McCoy & Thornton, 2014; McCoy & Banks, 2012).

The second measure taps into children's psychological adjustment, drawing on parent's responses to the *Strengths and Difficulties Questionnaire* (SDQ), completed for each child in the study at both 9 and 13 years of age. The SDQ is a brief mental health-screening questionnaire that provides balanced coverage of children's behaviours, emotions, and relationships. The questionnaire has been tested for reliability and validity[1] and is applicable to children and young people ranging from 4 to 16 years. The full scale includes equal numbers of items on each of five relevant dimensions, to which the response can be "not true", "somewhat true", "certainly true" (Goodman, 1997):

Emotional symptoms: including "many worries, often seems worried", "often unhappy, downhearted, or tearful", "many fears, easily scared".

Conduct: including "often fights with other children or bullies them", "often lies or cheats", "often has temper tantrums or hot tempers".

[1] Both the reliability and validity (concurrent, construct, and discriminant) of the SDQ total and five sub-scales, and the Piers Harris scale, have been established – for details see Murray et al., 2011; Thornton et al., 2016.

Hyperactivity: including "restless, overactive, cannot stay still for long", "easily distracted, concentration wanders", "sees tasks through to the end, good attention span" (reversed).

Peer relationships: including "rather solitary, likes to play alone", "generally liked by other children" (reversed), "has at least one good friend" (reversed).

Pro-social behaviour: including "considerate of other people's feelings", "helpful if someone is upset, hurt or feeling ill", "often volunteers to help others".

Previous research has highlighted the value of examining the total score and the sub-scales in assessing psycho-social wellbeing of children and young people (McCoy, Maitre, Watson, & Banks, 2016). Table A1 provided in Supplemental online material presents the descriptive statistics for these outcome variable (showing outcomes for Wave 1 and Wave 2 separately).

Explanatory variables

At each wave, the child is asked whether they own a mobile phone. Almost all children (98 per cent) had a phone when surveyed at age 13, so we drop the small number of respondents who did not have a phone at age 13 from the analysis and create a binary variable identifying those who had a phone at age 9 and those that received one later.

Psycho-social outcomes may of course be affected by many other influences on children. We control for many child characteristics when modelling these outcomes. Among the child characteristics included are gender, whether they have a learning difficulty, communication or co-ordination disorder, the extent to which they are engaged at school, and whether they received help from parents in completing homework. We also include school characteristics relating to the socio-economic composition of the school (Delivering Equality of Opportunity in Schools - DEIS – status, targeting schools with a greater share of socio-economically disadvantaged students), given that school social mix is known to be highly important across

a range of academic and socio-emotional outcomes (McCoy, Quail & Smyth, 2014). For family background, we include:

Economic capital as measured by family income (quintiles of equivalised household income), mother's education, and family structure;

Cultural capital according to the number of books in the home;

Number of stressful life events experienced by the child (including death or serious illness of family member); and

Mother's parenting style, classified as authoritative, authoritarian, permissive, or neglectful (see Dempsey, Lyons & McCoy, 2018).

Table A2 provided in Supplemental online material presents the descriptive statistics for the explanatory variables.

Methodology

The data available to us are particularly useful for addressing aspects of whether young people's psycho-social development is related to early mobile phone ownership as they move into adolescence, but rules out others. In particular, with a large longitudinal dataset that includes a range of psycho-social metrics, we are well placed to test for the presence of generalised associations with mobile phone ownership. We can also test for heterogeneity in effects, e.g. by gender, and variations in a wide range of outcomes. However, we lack data on the nature, duration or timing of use by those who have phones, and no attitudinal information on phone ownership or use is available to us.

Empirical approach

Ideally, we would like to measure the impact of mobile phone ownership on children's self-concept and psychological adjustment. However, detecting such causal effects presents

challenges. First, there are many personal and environmental characteristics that might act as confounding factors. Second, use of technology tends itself to be affected by individual and family characteristics. So even if we can detect associations, causation may run either way. However, access to longitudinal data gives us an opportunity to partially address these problems. With two waves of data on a large sample of children, we can use outcomes at age 9 to help control for pre-existing individual-level factors that do not change over time but which might influence outcomes at age 13. A range of other personal and household characteristics can also be included, using multiple regression models to separate out the partial effects of each. Because almost all children in our sample had mobile phones by age 13, the main difference among children available for study is between children who already had mobile phones at age 9 and those who obtained them some time in the following four years. Thus our models seek to measure the average effects of delaying mobile phone ownership by children beyond age 9. Unfortunately, the data do not tell us how long this delay extended on average.

We begin by modelling the Total Piers-Harris and SDQ scores to test for generalised associations with mobile phone ownership (Hypotheses 1 and 2), before estimating separate models by gender and for each subcomponent of these total scores. These regressions test Hypotheses 3 and 4.

We exploit the longitudinal aspect of our dataset by including variables from both Wave 1 (where the Study Child is aged 9) and Wave 2 (where the Study Child is aged thirteen). Our main explanatory variable (age of mobile phone ownership) comes from Wave 1 in which the Study Child indicates whether they own a mobile phone. The dependent variable in our models is always a Wave 2 variable, with the lagged Wave 1 dependent variable included as a control in the model. Below we illustrate the regression model in which $Y_{i,w=1,2}$ is the

dependent variable, $\boldsymbol{Z}_{i,w2}$ is a matrix of control variables at Wave 2, $\boldsymbol{X}_{i,w1}$ represents a matrix of control variables at Wave 1 and ε is an error term.

$$Y_{i,w2} = \alpha + \beta_1 Mobile\ Phone_{i,w1} + \beta_2 Y_{i,w1} + \beta_3 \boldsymbol{Z}_{i,w2} + \beta_4 \boldsymbol{X}_{i,w1} + \varepsilon$$

By controlling for the lagged level of the dependent variable, we seek to take account of any pre-existing differences among children at the start of the sample period. These pre-existing characteristics include whether children had phones by age 9, so the mobile phone effects in our models should relate to changes that occurred between age 9 and age 13.

Regarding the Wave 1 control variables used in this model, previous research (Dempsey, Lyons & McCoy, 2018) has shown that the likelihood of owning a mobile phone at this early age is shaped by family economic position, with higher socioeconomic groups much more likely to delay mobile phone ownership until after 9 years of age. Given that these socio-economic factors also influence self-concept and psychological adjustment (Kraus & Park, 2014; Jinkyung, Chan, Lodi-Smith, & Park, 2018; Richards & Paskov, 2016), we include them in our model to ensure that our explanatory variable of early mobile phone ownership is not suffering from omitted variable bias and simply acting as a proxy for socioeconomic status. Our matrix of Wave 1 control variables ($\boldsymbol{X}_{i,w1}$) therefore consists of gender, learning disability, school disadvantaged status (DEIS), frequency receiving assistance with homework, mother's highest level of completed education, number of books in the home, income quintile, family composition, mother's parenting style, number of stressful life events, and region[2]. In terms of the Wave 2 control variables ($\boldsymbol{Z}_{i,w2}$) we control for the type of secondary school attended and what year of school the Study Child is in.

A summary of the null hypotheses is shown in Table 1.

[2] Based on the NUTS 3 8-fold classification

[Table 1 about here]

Results

A simple approach to comparing outcomes for early owners of mobile phones to those without is to test if the group means are significantly different. Tables A3 and A4 in Supplemental material show the means and comparison tests for generalised associations at both Waves 1 and 2, while Tables A5 and A6 show them for subscales and split by gender. In general, the Piers-Harris outcomes show no significant differences by phone ownership status at Wave 1, whereas by Wave 2 small but significant differences had emerged. The gender-specific results suggest that differences in Wave 2 were more pronounced for the female subsample. In contrast, the mean SDQ scores tended to be significantly higher (i.e. less favourable) for the group that had mobile phones at age 9, with mixed results at age 13.

However, multivariate models including lagged outcome variables offer a more appropriate way to analyse these data given the likely importance of individual unobserved characteristics influencing psycho-social outcomes and non-random selection affecting mobile phone ownership at Wave 1. Table 2 presents the regression results for Total Piers Harris Score and Total SDQ Score at age thirteen with all respondents pooled. There is no evidence of a significant relationship between earlier mobile phone ownership and total scores on either scale. These results do not support Hypotheses 1 and 2, i.e. there is no detectable generalised association between early mobile phone ownership and psycho-social outcomes for children in this age group.

[Table 2 about here]

In contrast, we do find evidence of heterogeneous associations within the models of self-concept when we estimate separate models for sub-scales and split the sample by gender (see Table 3). These findings contradict Hypothesis 3 and support Hypothesis 4. The tests of

Hypothesis 3 are shown in the first two columns in the table, where the children of both genders are pooled but outcomes are at sub-scale level. Early mobile phone ownership is associated with about 0.1 fewer points on the Piers-Harris (PH) Behavioural Adjustment subscale and 0.07 fewer points on the PH Intellectual and School Status subscale at age 13 after controlling for the other factors in our models. In both cases the p-value is well below 1%. Lower scores on these two Piers-Harris subscales imply potentially higher levels of self-reported problematic behaviours and lower self-evaluation of abilities in intellectual and academic tasks. There is also some evidence of a positive association between early phone ownership and performance on the emotional subscale in the Strengths and Difficulties Questionnaire. An increased score on this subscale could indicate higher incidence of emotional difficulties among these children. However, this coefficient seems to be less statistically robust than for the two subscales discussed above.

[Table 3 about here]

Turning to Hypothesis 4, the four remaining columns in Table 3 show results of models with gender-specific samples. These results suggest that the overall associations described above for the Behavioural and Intellectual subscales are driven by the female sub-sample, where larger negative associations with low p-values are observed. The coefficients on these sub-scales are also negative for males, but their scale and significance are much lower than for females. We also note that the gender-specific models for the emotional subscale in the Strengths and Difficulties Questionnaire lack statistical significance although the scale of these coefficients is similar between gender groups. This casts further doubt on the robustness of the effect observed in the model with both genders together.

As an illustration of the scale of these effects, girls reporting having had two stressful life events scored 0.124 points lower on the PH Behavioural Adjustment subscale compared

to those reporting no stressful events. This association is of a similar magnitude to the one we observe for girls who are early owners of mobile phones. The PH Behavioural Adjustment coefficient corresponds to about 9.6% of the standard deviation for this score among girls in our dataset, while the PH Intellectual and School Status coefficient is about 12.4% of that score's standard deviation (standard deviations are reported in Tables A3 and A4 in Supplementary material).

Discussion

Commentators have argued that today's young generation is more fragile and risk averse than their predecessors because of mass adoption of the smartphone (Twenge, 2017). However, the evidence underpinning these and other sweeping claims is limited and based on "an abundance of simple univariate trends in youth attitudes and practice … [and a] relative lack of multivariate analysis" (Livingstone, 2018, p.119). In this context, experts repeatedly highlight the need to foster more and better research about and with young people growing up in the digital age (Livingstone, 2018; Pai, 2017). This study addresses this empirical gap, using rich longitudinal data to systematically examine how early mobile phone ownership is associated with young people's self-concept and psychological adjustment as they move into adolescence.

We find no significant generalised association between early mobile phone ownership and either measures of self-concept or psychological adjustment as children enter adolescence. The lack of negative associations offers counter-evidence to concerns raised by some theorists that these technologies might present significant new challenges for children (e.g. Twenge, 2017; Lepp, Barkley & Karpinski, 2014; McDaniel & Radesky, 2018). However, when we allow for differing associations in specific psycho-social domains and by gender we do find some grounds for concern. The finding of lower intellectual self-concept

scores among girls adopting mobile phones earlier complements previous research (Dempsey, Lyons & McCoy, 2018), which shows that early mobile phone ownership is associated with lower academic scores in adolescence. While the directional nature of this relationship has yet to be researched, one possibility is that reduced academic outcomes resulting from early mobile phone ownership are feeding into girls' beliefs around their intellectual abilities. The results also show girls adopting mobile phones earlier fare less well in terms of their self-assessed behavioural adjustment. The underlying processes through which early mobile phone ownership may be linked to adolescent girls' self-concept are less clear. Our bioecological framework highlights the evolving influences on children's development as they move into adolescence, and the expansion of their interactions beyond the family context. Boys and girls may be using mobile phones in different ways, and using them to interact differently with these broader systems. Perhaps mobile phones are providing girls with greater opportunities for such social comparison, opportunities which are impacting negatively for them. Earlier research has suggested mobile phone owners may experience greater anxiety as a consequence of a perceived obligation to remain constantly "on", always connected to a diversity of social networks through their phones (Lepp, Barkley, & Karpinski, 2014). Again, perhaps girls are more vulnerable to these pressures. Finally, while we find some associations between early phone ownership and girls' self-concept, the impact may be subtle, given that the results do not extend to how parents rate their children's psycho-social wellbeing.

Given the popularity of these technologies, they undoubtedly offer many valuable benefits. However, the challenge for policymakers and society more generally is how to maximise the potential of digital technologies for education and other purposes, while mitigating any negative effects from access. The findings suggest the need for policy attention, given that any negative impact on children's self-concept from mobile ownership

could impose significant costs on the individual and society. Earlier research finds significant associations between self-concept, behavioural adjustment and emotional wellbeing in childhood and later health status, educational attainment, and labour market outcomes (e.g. Marsh and O'Mara, 2008; Chowdry, Crawford, & Goodman, 2011; Mann, Hosman, Schaalma, & De Vries, 2004; Magnusson & Nermo, 2018). Hence, if mobile phones have the potential to negatively impact on dimensions of children's self-concept as they move into adolescence (and beyond), there could be valid economic and societal arguments for curtailing or delaying such mobile phone access, or at the very least raising awareness about the potentially negative effects. Further, given the distinct social profile of early phone adopters, being from lower income families and single parent households, any measures to curtail or delay access may serve to counter broader social inequalities in children's psycho-social and educational development. But single parent families, in particular, may need additional supports given that they may be managing a variety of conflicting needs and mobile phones may prove essential for parent and child alike despite potentially adverse impacts on parenting quality or child development (McDaniel, 2019).

Limitations

There is likely to be unobserved individual heterogeneity in early phone ownership. This could include variation in the type and model of mobile phone, whether the device allows internet access and the actual timing of phone ownership. The nature of phone usage is also likely to vary, depending on parental rules around the timing and intensity of usage and the extent of parental mediation in phone usage (Shin, 2018), "parental control" software, expenditure allowed on the phone, school rules around phone usage, and peer group ownership rates. Our data do not capture these variations, and the nature of mobile phone

applications and their usage by children are changing over time.[3] A second limitation concerns our inability to unpack the processes through which early phone access impacts on the socio-emotional development of children. Third, as noted earlier we do not know from the data how long it was between age 9 and the average respondent taking up mobile phone usage.

A further limitation concerns the possible effects of panel attrition on our results. It is conceivable that children with unusually positive or negative individual associations between mobile phone ownership and psycho-social outcomes were more likely to drop out of the sample between waves, leading to selection bias when we estimate effects at Wave 2. As shown in Table A7 in Supplementary material, the average child exiting between waves was a mobile phone owner with a slightly lower than average set of Piers-Harris scores. Because we control for each child's scores at Wave 1 when estimating scores at Wave 2, the composition effects of sample attrition should not directly affect the model coefficients. Nevertheless, we cannot rule out the possibility that some unobserved factor is associated both with a higher chance of leaving the sample and a more positive or negative individual effect of mobile ownership.

[3] For example, the Wave 1 survey took place in 2007/08, before smartphones were widespread.

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Table 1
Summary of null hypotheses tested in regression models

H1: $\beta_1 = 0$ in the main PH model would imply no generalised association between early mobile phone ownership and self-concept.
H2: $\beta_1 = 0$ in the main SDQ model would imply no generalised association between early mobile phone ownership and psychological adjustment.
H3: $\bigvee_a^b(\beta_a = \beta_b)$ in the subdomain models would indicate that any effects are consistent across subdomains of each metric (*a* and *b* indicate different subdomains)
H4: $\beta_1^M = \beta_1^F$ would imply males and females exhibit the same patterns of associations for each outcome (*M* denotes coefficients with the male sample, *F* the female sample)

Table 2
OLS regression results for models of Total Piers-Harris and Total SDQ Scores at age 13

		Total Piers-Harris Score		**Total SDQ Score**	
Variable	**Category value**	**(Model 1)**		**(Model 2)**	
		β	***p-value***	***β***	***p-value***
Mobile Phone at age 9	No	REF		REF	
	Yes	-0.0529	0.121	0.0628	0.542
W1 Total Piers Harris Score		0.307	0.000		
WI Total SDQ Score				0.562	0.000
School Year	1st Year	REF		REF	
	2nd Year	-0.209	0.000	0.27	0.004
W2 School Type	Vocational	REF		REF	
	Girls' Secondary	0.0461	0.361	0.00399	0.979
	Boys' Secondary	-0.0168	0.755	-0.141	0.370
	Coed Secondary	0.00841	0.871	-0.0255	0.867
	Community/ comprehensive	-0.0138	0.788	-0.0975	0.545
Gender	Male	REF		REF	
	Female	-0.363	0.000	-0.14	0.275
Disability	No	REF		REF	
	Yes	-0.334	0.000	1.25	0.000
W1 DEIS status	Non-Disadvantaged	REF		REF	
	Urban Band 1	-0.0574	0.457	0.981	0.000
	Urban Band 2	0.0539	0.471	0.82	0.000
	Rural DEIS	0.0228	0.796	0.577	0.057
Homework Help	Always/Nearly Always	REF		REF	
	Regularly	-0.0103	0.806	0.155	0.230
	Now and Again	-0.0375	0.384	-0.0791	0.525
	Rarely/Never	0.0139	0.788	-0.293	0.057

Table 2
OLS regression results for models of Total Piers-Harris and Total SDQ Scores at age 13

		Total Piers-Harris Score		**Total SDQ Score**	
Variable	**Category value**	**(Model 1)**		**(Model 2)**	
		β	***p-value***	***β***	***p-value***
PC Education	Higher Secondary/ Vocational/Technical	REF		REF	
	None or primary	-0.0389	0.689	0.433	0.262
	Lower Secondary	-0.0334	0.533	0.171	0.309
	Non Degree	-0.0256	0.549	-0.00188	0.988
	Primary Degree	-0.00145	0.976	-0.196	0.160
	Postgrad Degree	-0.0117	0.841	-0.212	0.194
Books in home	More than 30	REF		REF	
	Less than 10	0.147	0.026	0.197	0.335
	10 to 20	-0.00835	0.854	0.0219	0.876
	21 to 30	0.0122	0.795	0.215	0.129
Income Quintile	Highest Quintile	REF		REF	
	Lowest Quintile	0.0053	0.935	0.605	0.003
	2nd Quintile	-0.0762	0.153	0.359	0.026
	3rd Quintile	-0.0348	0.490	0.184	0.209
	4th Quintile	-0.0274	0.563	0.0537	0.679
	Missing Income	-0.0110	0.869	-0.239	0.202
Household Type	Couple 3 or more children	REF		REF	
	Single Parent 1 or 2 children	-0.128	0.061	0.402	0.065
	Single Parent 3 or more children	-0.239	0.023	0.0458	0.888
	Couple 1 or 2 children	-0.0289	0.396	0.368	0.000
Parenting Style	Authoritative	REF		REF	0.000
	Authoritarian	-0.287	0.001	0.572	0.027
	Permissive	0.0111	0.797	-0.0525	0.685
	Neglectful	-0.106	0.344	0.144	0.692
No. of stressful life events	None	REF		REF	
	One	-0.0800	0.054	-0.0350	0.770
	Two	-0.136	0.003	0.0853	0.530
	Three	-0.164	0.005	0.321	0.085
	Four or more	-0.141	0.068	0.485	0.040
Constant		3.15	0.000	2.14	0.000
Region Controls		Yes		Yes	
R^2		0.146		0.405	
Observations		6,302		6,713	

Note: robust standard errors

Table 3

Regression coefficients on owning a mobile phone at age 9 in models of Piers-Harris and SDQ total scores and subscales at age 13, for all respondents and by gender

	All Respondents		**Male**		**Female**	
	β	***p-value***	***β***	***p-value***	***β***	***p-value***
Piers-Harris Total Score	-0.0529	0.121	0.0434	0.383	-0.126	0.008
Piers-Harris Subscales						
Behavioural	-0.0999	0.001	-0.0785	0.067	-0.110	0.005
Intellectual	-0.0728	0.005	-0.0186	0.606	-0.120	0.002
Physical Appearance	-0.0258	0.357	0.0484	0.220	-0.088	0.028
Anxiety	-0.00159	0.953	0.0416	0.249	-0.033	0.406
Popularity	0.0356	0.147	0.0708	0.039	0.00725	0.838
Happiness	-0.0127	0.649	0.0277	0.471	-0.0429	0.286
SDQ Total Score	0.0628	0.542	-0.0548	0.714	0.161	0.260
SDQ Subscales						
Emotional	0.0896	0.045	0.0772	0.224	0.0885	0.167
Conduct	0.0103	0.745	-0.0122	0.793	0.0319	0.462
Hyperactivity	0.00627	0.894	-0.0107	0.879	0.0261	0.682
Peer	-0.0198	0.552	-0.0919	0.062	0.0487	0.289
Prosocial	-.00385	0.912	-0.0537	0.301	0.0377	0.422

Notes: robust standard errors; Respondents' scores at the age of 9 are included, alongside school year (W2), school type (W2), gender, disability status (W1), DEIS status (W1), homework help (W1), primary care-giver education (W1), number of books in home (W1), income quintile (W1), household type (W1), parenting style (W1), number of stressful life events (W1), region controls (W1) as in the Total Score Models in Table 1