How much is too much? Examining the relationship between digital screen engagement and psychosocial functioning in a representative cohort study

Short title: Screens and Psychosocial Functioning

Abbreviations: None.

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Abstract

Objective Previous studies have offered mixed results regarding the link between digital screen engagement and the psychosocial functioning of young people. In this study we aimed to determine the magnitude of this relation, to feed into the discussion regarding whether amount of digital screen time has a subjectively significant impact on the psychosocial functioning of children and adolescents.

Methods We analyzed cross-sectional data from primary caregivers participating in the National Survey of Children’s Health (NSCH), an annual nationally representative survey fielded by the US Census Bureau between June 2016 and February 2017. NSCH uses an address-based sampling frame and both web- and paper-based data collection instruments to measure psychosocial functioning and digital engagement, including a modified version of the Strengths and Difficulties questionnaire and caregiver estimates of daily television- and device-based engagement, respectively.

Results The expected parabolic, inverted U-shaped, relationship linking caregiver-reported digital screen engagement to psychosocial functioning was found replicating past findings suggesting moderate levels of screen time, one to two hours a day, was associated with slightly higher levels of psychosocial functioning compared to lower or higher levels of engagement. Assuming that digital engagement affects perceived psychosocial functioning rather than the converse, children and adolescents would require 4hr 40 min of television-based engagement and 5hr 8 min of daily device-based engagement before caregivers would be able to notice subjectively significant variations in psychosocial functioning.

Conclusion The possible influence of digital screen engagement is likely smaller and more nuanced than we might expect. These findings do not rule out the possibility that parents might only notice very high levels of screen time when their child manifest pronounced psychosocial difficulties. Future work should be guided by transparent and confirmatory programs of research.
Introduction

Advances in technology have increased the ubiquity and utility of digital devices, making them an inescapable feature of everyday life. Ease of use and reduced cost allow growing populations of young people to access digital devices, games, and online platforms. As the share of time children and adolescents spend using such digital devices has increased, so too have the concerns about their relationship with mental health and psychosocial functioning. Given the absence of compelling evidence linking digital screen engagement to psychosocial functioning, professional guidance provided to caregivers and educators has been predominately shaped by a sense of precaution that prioritizes digital engagement limits. This first took the form of the ‘2x2 Rule’, advice that children under two should have no screen time and children over two should be limited to two or fewer hours of daily digital engagement. Unfortunately, there was insufficient evidence supporting this guidance and research on caregivers found that the guidance was difficult to follow, given the many advantages of digital technology, such as video chat with family and friends.

Professional organizations in the West rethought this advice in 2016, introducing guidance focusing on the quality of screen time and favoring family diaries of digital engagement. Responses to concerns about digital engagement and psychosocial functioning vary across the globe. South Korea’s 2011 ‘Shutdown Law,’ for example, restricted youth access to online platforms, including games and social media, between midnight and six in the morning. This legislation aimed to reduce technology addiction and bolster sleep. It was in place for nearly six years before research gauging its effectiveness indicated that it did not achieve either of these goals. In both cases, professional advice and legislative action fell short of positively impacting youth mental health and functioning because change was pursued and without the necessary scientific support.

Most existing research examining the impact of digital engagement focuses on concerns regarding relations between digital engagement and pediatric outcomes. A number of these studies
have identified small associations (e.g. $rs < 0.10$), suggesting digital engagement might displace opportunities for physical activity$^{10,11}$ and the learning of essential skills.$^{12}$ Evidence from longer-term longitudinal studies, with robust covariates, indicate that potential displacement is inconsistent: Those who reported the highest levels of non-interactive forms of engagement, such as watching television showed slightly lower levels, about 0.09 $SD$s, of psychological functioning at follow-up, but this relationship was entirely absent for interactive activities such as gaming.$^{13}$ Many studies however have failed to show any relations linking media use and learning in young children.$^{14,15}$

Two recent studies, one focused on British adolescents and another with young American children, indicate that the relations between digital screen engagement and psychosocial outcomes are non-linear.$^{16,17}$ The idea that parabolic function links digital engagement to mental well-being, dubbed the ‘Goldilocks hypothesis,’ has received some empirical support. Briefly, moderate levels of digital screen time, one to two hours a day, may be associated with slightly higher levels of key outcomes compared to engagement at either lower or higher levels. Although this hypothesis makes intuitive sense, as many apps and digital technologies are useful for informing and connecting young people, results have not uniformly supported it.$^5$ Where research has identified parabolic trends, the average correlates of positive or negative digital engagement found in this previous research are very small, accounting for less than 1% of variability in child outcomes.$^{18}$ In other words, though many of these relations are statistically significant, more than 99% of variability in psychosocial outcomes is unrelated to digital engagement. This pattern of results highlights a disconnect between the statistically significant relations identified in the literature and relations that could be understood as relevant to caregivers, policymakers, or health professionals. This gap undermines effective evidence-based mental health policymaking for children in the digital age.

This issue centers on the degree to which statistical significance, evidence a hypothesis test rejects the null hypothesis, provides compelling evidence that digital technology influences young people. This assumption has not been empirically supported. Ferguson (2009) argued that not all
statistically significant media effects are practically significant; instead he proposed a minimum effect, equivalent to a standardized Cohen’s \( d \) of 0.41, is for those studying the impact of digital media on its users. Ferguson argued for this Smallest Effect Size of Interest (SESOI), in part, because digital media engagement measures and self-report outcomes are imperfect.\(^{19}\) He also cautioned researchers to be context specific, weighing the merits and potential unreliability of study methodology against potential real-world impact. This advice mirrors a broader literature concerned with subjective effects the \textit{Minimally Important Differences} (MID),\(^ {20,21}\) yolks the threshold for an association someone can consistently report an internal state to a SESOI of a Cohen’s \( d \) of 0.50. Reviews of the literature and suggest this may be the smallest difference research subjects and clinical patients are able to reliably distinguish in pain, functioning, and health outcomes. The MID, therefore, provides an empirically-grounded gauge of the extent to which excessive digital screen time has a subjectively significant effect. Instead of relying on statistical significance, we can use the MID cut-off to derive the point at which digital screen engagement starts to have an association with psychosocial functioning a caregiver could possibly notice.

With this in mind, the goal of the present research was to rigorously investigate the association between digital screen time and psychosocial functioning, determine the magnitude of this link. To this end, we analyzed cross-sectional data from two nationally-representative cohort data sets and examined the linear and parabolic relations between technology use and pediatric outcomes.\(^ {16}\) Our goals were twofold. First, we wanted to conduct a rigorous confirmatory test of the Goldilocks hypothesis using a North American sample reflecting experiences of a wider range of young people aged six months to 17 years. Second, assuming digital screen engagement affects psychosocial functioning aimed to empirically identify the point at which the former might influence the latter to a level a caregiver might be able to reliably detect. To avoid potential problems with researcher degrees of freedom, a problem known to influence what we understand about the relations linking technology use to youth outcomes,\(^ {22}\) we analyzed well-validated measures of screen time and
psychosocial functioning, defining a number of key control variables at the individual, family, and community levels, and data analysis was preregistered to provide a confirmatory replication of previous approaches.

**Methods**

The cross-sectional data analyzed in this study were derived from self-report surveys completed by caregivers living in the United States (US) as part of the 2016 National Survey of Children’s Health (NSCH). Conducted on behalf of the US Department of Health and Human Services, Health Resources and Services Administration’s Maternal and Child Health Bureau, the NSCH uses an address-based sampling frame and both web-based and mailed paper data collection instruments fielded by the US Census Bureau. Fieldwork was conducted between June 2016 and February 2017, and the data collected reflects a nationally representative sample of children and young people living in all 50 states and the District of Columbia. State-level responses ranged from a low of 638 (Missouri) to a high of 1,351 (Minnesota). Caregivers spent 35 minutes on average completing either a paper questionnaire (9,719, 19.4%) or an online instrument (40,493, 80.6%), answering questions about themselves, their households, and children ranging in age from 6 months to 17 years. The sample was evenly divided between male (n = 25,733, 51.2%) and female (n = 24,479, 48.8%) children.

**Ethical Review and Open Science Practices**

Ethical review was conducted by The US Department of Health and Human Services and study data is available online on the CDC website. All of the code required to restructure and analyze these data are available for download on the Open Science Framework.

**Measures**

**Outcome Variable**

**Psychosocial functioning.** Caregivers completed an adapted version of the Strengths and Difficulties Questionnaire, a widely used measure of adolescents’ social and emotional functioning
that has been validated in a range of community, academic, and clinical settings. Caregivers used a three-point scale (“Definitely true”, “Somewhat true”, “Not true”) to rate how eight items reflected their child’s strengths (e.g. “This child works to finish tasks he or she starts”) and difficulties (e.g. “This child bullies others, picks on them, or excludes them”). In line with the analysis plan, the scale demonstrated good internal reliability and individual scores were computed by reverse coding negatively worded items and averaging across responses ($M = 2.70, SD = 0.33, \alpha = .79$).

**Explanatory Variables**

**Television-based engagement.** Caregivers estimated their child’s daily engagement with television-based activities by responding to the item: “On an average weekday, about how much time does [child name] usually spend in front of a TV watching TV programs, videos, or playing video games?” using a six-point scale ranging from: “None” to “4 or more hours”. Nearly all caregivers responded (98.9%, $n = 35,310$). On average young people spent 1hr 41min ($SD = 1hr 4min$) a day using television-based engagement. Table 1, left, presents the observed frequencies.

**Device-based engagement.** Caregivers estimated their child’s daily engagement with device-based activities by responding to the item: “On an average weekday, about how much time does [your child] usually spend with computers, cell phones, handheld video games, and other electronic devices?” using the same scale as was used to measure television-based engagement. Nearly all caregivers responded (98.9%, $n = 35,335$), and they reported young people to spend an average of 1hr 53min ($SD = 1hr 13 min$) on device-based engagement. Table 1, right, presents the observed frequencies.

**Control Variables**

Because previous research suggests that digital engagement and psychosocial functioning may be correlated with child-, family-, and community-level variables, a series of control variables were included in the hypothesis-testing models detailed in the analysis plan. Adjusting for the
confounding influence of these factors serves to disambiguate the correlates of digital engagement from other factors on the basis of the existing literature.\textsuperscript{13,16,17} Child-level variables included age and gender, white or non-white race/ethnicity, presence of major life stressors, social support, and general health. Family-level variables included whether or not caregivers had completed secondary school, family adjustment, whether the family was able to get by financially, whether the family could afford food, and whether they received government assistance. Finally, community-level variables comprised of neighborhood conditions including measures of the presence of “vandalism such as broken windows or graffiti,” affordances for outdoor activities such as “a recreation center, community center, or boys’ and girls’ club?” and “a park or playground?”, as well as social cohesion indicators like “people in this neighborhood help each other out, and social support: “When we encounter difficulties, we know where to go for help in our community”. The full list of control variables are detailed in the study’s preregistration materials.\textsuperscript{24}

Results

Preliminary Analyses

Zero-order Pearson product-moment correlations (see Table 2) indicated that television-based \((r = -.19, p < .001)\) and device-based \((r = -.16, p < .001)\) were negatively associated with psychosocial functioning. Ancillary analyses furthermore highlighted that the child-, caregiver-, and household-level control variables were significantly associated with daily digital engagement and psychosocial functioning in 38 of the 39 observed pairwise comparisons. This pattern of correlations underlined the empirical value of adjusting for the variability linked to the control variables in hypothesis testing as detailed in the analysis plan.

Confirmatory Analyses

In line with the preregistered data analysis plan,\textsuperscript{28} two multiple regression models were used to test the correlates of television- and device-based digital screen engagement. In the first step, the control variables detailed above were included in the models and, in subsequent steps, both linear
and non-linear (i.e. parabolic) estimates of digital screen engagement were entered as predictors. Whether the linear and parabolic relations with digital screen engagement accounted for significant shares of variance in psychosocial functioning was of special interest in this model testing procedure (see Table 3). If the parabolic terms were significant, our analysis plan specified calculating the local extrema – the inflection point at which the slope switches sign – to determine what constituted moderate engagement. Our plan specified splitting the data at this value to evaluate two additional regression tests. These tests examined the linear relationships linking digital engagement to children’s and young people’s psychosocial functioning at either side of these inflection points (see Table 4).

Three deviations from the previously preregistered analysis plan merit mention. First, the sample size \((n = 35,718)\) was smaller than expected \((n = 55,000\) and \(77,000)\) because the scope of the 2016 NSCH was reduced since data collection now happens on an annual basis. Second, although it does not change the significance, direction or standardized magnitude of correlations under scrutiny, we standardized our criterion variable for psychosocial functioning to provide a consistent unit for comparing across confirmatory, exploratory, and sensitivity analyses. Finally, we included an additional control variable reflecting the mental health of the primary caregiver as a result of feedback received during the peer review process.

Results from the television-based digital engagement models, see top of Table 3, provided evidence that the association in question had both linear \(B = -0.078\) (95% CI \([-0.069, -0.194\]) and parabolic components, \(B = -0.040\) (95% CI \([-0.033, -0.207\]). Analysis indicated that the local maximum, the ‘Goldilocks level’ was 1hr 03min (see Table 4). The data were split at this local extremum. Results show significant but small positive associations below the extremum (using television lower), \(B = 0.061\) (95% CI \([0.024, 0.099]\)). There was a negative trend in evidence when

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1 Findings were virtually identical in terms of both effect size and significance with and without this control.
examining the data above the extremum (using television more than the optimum amount), $B = -0.138$ (95% CI [-0.157, -0.119]).

Results from the device-based digital engagement models, see top of Table 3, provided evidence that the association also consisted of linear, $B = -0.073$ (95% CI [-0.081, -0.064]) and parabolic components, $B = -0.041$ (95% CI [-0.048, -0.034]). The ‘Goldilocks level’ for device-based digital engagement was at 1hr 19min (see Table 4). Using this optimum to bifurcate the data, we found significant but small positive associations below the extremum, $B = 0.113$ (95% CI [0.174, 0.060]), and a negative trend above the extremum, $B = -0.131$ (95% CI [-0.115, -0.184]).

**Exploratory Analyses**

We conducted a series of exploratory tests to estimate the level of digital engagement necessary for caregivers to be able to subjectively sense a difference in their child’s psychosocial functioning. Results from analyses focusing on television-based digital engagement indicated that every hour of engagement past the maximum (i.e., 1hr 02min) was associated with -.138 standard deviations of drop in psychosocial functioning as judged by caregivers. Using the $SD = 0.50$ MID standard we found a child would need to engage 4hr 40min (1hr 02 min + 3hr and 38 min) of television-based activities on a daily basis for caregivers to notice a difference in their child’s psychosocial functioning.

Results examining digital device-based engagement indicated that every hour of engagement past the maximum (i.e. 1hr 19min) was associated with a -.131 standard deviation drop in psychosocial functioning. Following the calculations used for television-based engagement, we found children would require at least 5hr 08min of device-based engagement every day before caregivers could notice a difference in their child’s psychosocial functioning.

Said differently, if we assume caregiver-reports digital screen engagement affects their psychosocial functioning rather than the converse, our analyses suggest a young person would have to be at least 2.8 standard deviations above the average for television-based engagement, or 2.7
standard deviations above average for device-based use, before a caregiver would be able to sense any significant differences in psychosocial functioning.

**Sensitivity Analyses**

A final series of analyses was conducted to test the robustness of the results reported above, using a more recent dataset drawn from the latest round of the NSCH. The methodology of the 2017 NSCH was nearly identical to the 2016 methodology, except that the sample size was smaller \((n = 21,533)\). Measures of psychosocial functioning \((M = 2.76, SD = 0.33, \alpha = .78)\), television-based engagement \((M = 1\text{ hr } 30\text{ min}, SD = 1\text{ hr } 6\text{ min})\) and device-based engagement \((M = 1\text{ hr } 32\text{ min}, SD = 1\text{ hr } 16\text{ min})\) were the equivalent in both waves.

The pattern of correlations and regression models broadly mirrored those generated from our preregistered analyses of the 2016 NSCH with the exception of the correlations associated with television-based digital engagement. Both linear \(B = -0.081 (95\% \text{ CI } [-0.094, -0.068])\), and parabolic \(B = -0.023 (95\% \text{ CI } [-0.034, -0.013])\) trends were in evidence as expected, but both the trends below \(B = -0.054 (95\% \text{ CI } [-0.076, -0.031])\) and above \(B = -0.145 (95\% \text{ CI } [-0.219, -0.071])\) the local maximum were negative. These results did not support the Goldilocks hypothesis for television-based screen time in the 2017 data. In place of an increase, an extremely small negative trend turned significantly more negative after 2hr 23min of daily engagement. The average child would need to spend 5hr 50min engaging with television-based activities on a daily basis for caregivers to notice a lower level of psychosocial functioning in their child.

As expected, there were both linear \(B = -0.078 (95\% \text{ CI } [-0.091, -0.066])\), and parabolic \(B = -0.046 (95\% \text{ CI } [-0.056, -0.036])\) links relating device-based digital engagement to psychosocial functioning. The local maximum for device-based digital engagement in the 2017 NSCH dataset (1hr 20 min) was one minute higher compared to the extremum derived from the 2016 NSCH data. Using this value to bifurcate the data, we found a significant but small positive association below the extremum, \(B = 0.149 (95\% \text{ CI } [0.089, 0.209])\), and negative association above the extremum, \(B = -
0.138 (95% CI [-0.115, -0.186]). Further, analyses indicated children would have to use digital devices for at least 4hr 57min each day before caregivers would be expected to notice a difference in their child’s psychosocial functioning.

**Discussion**

As digital devices are playing an increasingly large role in childhood and adolescence, research probing the relations between screen-based technologies and children’s wellness is critically needed. The present work aimed to investigate whether and at what levels does digital engagement relate to lower levels of psychosocial functioning. Guided by pressing policy and clinical demands, the existing literature, 16,17 and an approach grounded in open science, 29 the results provide evidence for a number of outstanding questions concerning excessive digital technology engagement.

In line with previous research findings, parabolic relations between digital screen engagement and psychosocial functioning were in evidence in three of four instances tested. In both preregistered analyses, the associations linking television- and device-based digital engagement to psychosocial outcomes could be described as parabolic, with those having levels of engagement at 1hr 2min and 1hr 19min showing higher levels of psychosocial functioning compared to non-users. Children who used digital devices for less time showed a positive relationship between their digital engagement and psychosocial functioning – the opposite trend was clear if they used digital devices more. Because both the positive and negative correlates of digital engagement were very small, in terms of standardized effect sizes, there needs to be an empirical frame to judge at what point these associations would be related to practically important differences in psychosocial functioning.

To address this, we performed exploratory analyses to answer the question of how much time, over and above moderate engagement does a young person have to engage with screens before an association with psychosocial difficulties could be detected by a caregiver? Given such judgements are inherently subjective, it was determined that a minimum effect size, grounded in research on human experience was needed. 20,21 We used this basic threshold and found that an average young
person would need to engage with television- and device-based screen activities for about five hours a day before a parent would be able to tell the difference in functioning if one assumes the former influences the later. This is not to say the association was significant in clinical terms. For this, to be the case the association would have to be substantially larger than the MID ($d > 1.5$) before a media researcher would be justified in drawing such an inference.\textsuperscript{30} Instead, the data analyzed here, suggested an empirical basis for identifying excessive use might, estimating it to be about three standard deviations above the population mean.

This is a noteworthy finding given these estimates were outside of the measured range of digital engagement in the NHSC dataset. Said differently, the levels of digital engagement we estimated were necessary to observe a subjectively detectable difference in psychosocial functioning were well above the 0 to 4 hours range that caregivers were provided to rate their child’s digital engagement. This suggests that very few children, if any, routinely use television- and device-based screens enough, on average, to be understood to present meaningfully lower levels of psychosocial functioning. Instead, these findings indicate that other dimensions of digital engagement including the content of and caregiver engagement with screens provide more promising predictors of psychosocial functioning.\textsuperscript{31} These results speak to the larger literature concerned with the potential effects of digital screen time on young people and suggest that statistical significance, where accompanied by study preregistration, provides necessary but insufficient evidence for determining whether digital screens have a practically significant association with the health and well-being of young people.\textsuperscript{18}

Those drafting guidance for caregivers, educators, and health professionals should be informed by these findings. Though small, the positive correlations linking moderate digital engagement, between one and two hours a day, and psychosocial functioning is evident both in this study and in two earlier investigations of young people aged 6 months to 17 years in the U.K and U.S.\textsuperscript{16,17} These associations speak to the idea that digital engagement, depending on how it is measured, does not
necessarily displace positive developmental experiences such as face-to-face socializing. Further, the UNCRC is clear that young people have a right to play and information, if rich analogue opportunities fail in providing this, digital contexts can be an invaluable avenue for access. When viewed in this light, calls for blanket technology bans and age-based restrictions on technology access do not constitute evidence-based or indeed ethical advice when understood through a wider human rights framework. Moreover, this study’s findings provide a framework for deriving empirically grounded guidance for engagement time. Applying the MID as a SESOI and using these data as a guide, our results suggest that the briefest empirically defensible time-based limit would at least five hours a day of screen-based engagement. We would not advise such a limit however as the nature of the data under analysis cannot rule out plausible reverse causality.

Those studying the impacts of media on users should also find the results and approach of this study useful. Though the literature examining the correlates of technology engagement is largely exploratory and nontransparent, this work represents one of a growing number of preregistered and transparent investigations into digital media use and its association with diverse outcomes including aggression, sleep quality and duration, psychological well-being, and behavioral dysregulation.

In terms of empirical robustness, this study provides a new and stringent baseline for scholarship investigating the health correlates of technology use. Whereas Ferguson suggested the target SEOSI would have to be in the neighborhood of $d = 0.41$ to consider an association with media use practically significant, the present study expanded on clinical work and adopted a higher threshold for a meaningful difference in psychosocial functioning. Given that the reported influence and impact of digital devices is inherently subjective, the present research suggests that the MID SESOI should be the default for judging whether an association between digital engagement and pediatric outcomes are subjectively, but not clinically, significant. Deviations from this minimum value should make their scientific and policy rationale for anchoring results to other
thresholds explicit, while additionally conducting power analyses prior to data collection to ensure their work is sensitive to such thresholds.

**Limitations**

The present study should be carefully considered in light of a number of limitations that – if addressed in future research – can further improve our understanding of digital engagement effects. First, because the data analyzed in this study is cross-sectional and observational, these analyses and cannot establish directionality or causality. It is possible – as we assume in this discussion – that screen time influences psychosocial functioning – but it is also possible that caregiver perceptions of psychosocial functioning influences their perceptions of their child’s screen time. There are reasonable that alternative explanations, such as a third factor (e.g., parenting style) responsible for both detriments to psychosocial functioning and higher screen time, but these possibilities would reduce the identified effect size rather than increase it. Further, the current design did not allow within-person longitudinal trends in digital engagement and psychosocial functioning to be examined. Because the NSCH is conducted on an annual basis it provides opportunity to test whether patterns observed herein replicate over time, as we did with our sensitivity analyses, but it cannot speak to the longer-term longitudinal impacts of technology use. Future research should focus on similar high-quality data from experience sampling and longitudinal datasets.

Second, both the explanatory and outcome variables analyzed in this work were single-source data provided by caregivers at one time point. Such data are vulnerable to response bias (e.g., because a parent’s concern leads him or her to both screen time and psychosocial functioning as exaggerated, or alternatively because a parent wants to be viewed favorably and so reports both limited screen use and higher child psychosocial functioning).

Future research should therefore endeavor to use convergent self-reports from multiple respondents (children, caregivers, teachers, nurses) over time to rule out reverse causality, and integrate device- or platform-level trace data to build a fuller picture of the relations at play. To
these ends, new collaborative data initiatives such as the Adolescent Brain Cognitive Development study\textsuperscript{41} provide the best near-term resources for scientists interested in the longer-term impacts of digital engagement on pediatric outcomes. Finally, the present study focused entirely on the quantity, not quality, of two different types of digital screen engagement. Those coordinating cohort studies, such as the NSCH, should include data regarding on the structure, features, and content of varied mediums.

**Conclusions**

Given the ubiquity of digital devices, the idea that their use relates to lower psychosocial functioning of children and young people is a concerning one. Due to the high professional stakes for clinicians and scientists making claims about the positive and negative implications of digital engagement, studies examining their relations with wellness and functioning must investigate the most pressing policy questions whilst being grounded in transparent scientific practices. This study presents one such attempt and provides a positive example for a topic more often characterized by media hype rather than reliable science. Although data rely on a large but cross-sectional dataset, by building on this strong and transparent foundation, the study’s findings speak to a rapidly developing area of research. The body of research suggests that the relations between digital screen time and health outcomes are parabolic and that the negative correlates of excessive screen time are only subjectively felt after very long periods of daily digital engagement. Digital screen time is only one of many challenges presented by modern digital childhood, and it remains to be determined whether it is useful topic for research councils, scientists, and clinicians to be devoting time, attention and research resources to.
References


20. Miller GA. The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychol Rev. 1956;63(2):81-97. doi:10.1037/h0043158


27. The Author(s). Study Registration: A Confirmatory Investigation of Digital Screen Time Effects on Psychosocial Functioning. https://osf.io/w4r78/?view_only=afb49aa6dcd4e009a30c7f6e879856e. Published 2018.


Table 1.

*Observed Frequencies of Daily TV-Based and Device-Based Engagement.*

<table>
<thead>
<tr>
<th>Daily hours</th>
<th>TV-Based Engagement</th>
<th>Device-Based Engagement</th>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
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<tr>
<td>None</td>
<td>1,455</td>
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<td>&lt; 1 hour.</td>
<td>5,966</td>
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<td>1hrs.</td>
<td>9,820</td>
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<td>2hrs.</td>
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<td>3hrs.</td>
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<td>&gt; 4hrs.</td>
<td>3,108</td>
<td>8.8</td>
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</table>

*Note.* Percentages reflect values across all valid responses.
### Table 2. Observed Zero-Order Correlations Between Observed Variables

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<th>1.</th>
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<th>4.</th>
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<td>2. Female</td>
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<td>3. Parent Education</td>
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<td>4. Family Adjustment</td>
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<td>.024**</td>
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<td>5. Non-white race/ethnicity</td>
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<td>.011*</td>
<td>-.084**</td>
<td>-.002</td>
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<td>6. Hard Getting By</td>
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<td>-.006</td>
<td>-.050**</td>
<td>-.149**</td>
<td>.031**</td>
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<tr>
<td>7. Affording food</td>
<td>-.011*</td>
<td>-.007</td>
<td>-.079**</td>
<td>-.130**</td>
<td>.077**</td>
<td>.600**</td>
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<td>8. Neighborhood affordance</td>
<td>-.013*</td>
<td>-.004</td>
<td>.069**</td>
<td>.069**</td>
<td>.056**</td>
<td>-.169**</td>
<td>-.167**</td>
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<td>9. major life stressors</td>
<td>.095**</td>
<td>.016**</td>
<td>-.047**</td>
<td>-.135**</td>
<td>.069**</td>
<td>.315**</td>
<td>.281**</td>
<td>-.097**</td>
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<td>10. Child's General Health</td>
<td>-.052**</td>
<td>.012*</td>
<td>.097**</td>
<td>.175**</td>
<td>-.071**</td>
<td>-.239**</td>
<td>-.228**</td>
<td>.096**</td>
<td>-.200**</td>
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<td>11. social support</td>
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<td>.027**</td>
<td>.077**</td>
<td>.088**</td>
<td>-.106**</td>
<td>-.080**</td>
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<td>-.035**</td>
<td>.087**</td>
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<td>-.010</td>
<td>.086**</td>
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<td>-.137**</td>
<td>-.324**</td>
<td>-.323**</td>
<td>.220**</td>
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<td>.230**</td>
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<td>13. TV-Based engagement</td>
<td>.118**</td>
<td>-.112**</td>
<td>-.045**</td>
<td>-.117**</td>
<td>.049**</td>
<td>.152**</td>
<td>.140**</td>
<td>-.072**</td>
<td>.121**</td>
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<td>14. Device-Based engagement</td>
<td>.437**</td>
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<td>-.027**</td>
<td>-.165**</td>
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<td>.125**</td>
<td>.111**</td>
<td>-.040**</td>
<td>.147**</td>
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<td>-.063**</td>
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<td>.485**</td>
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<td>15. Psychosocial Functioning</td>
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<td>.044**</td>
<td>.287**</td>
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<td>-.261**</td>
<td>-.228**</td>
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<td>-.289**</td>
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<td>.101**</td>
<td>.268**</td>
<td>-.192**</td>
<td>-.163**</td>
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</table>

Note. **p < 0.001, *p < 0.05.
**Table 3.** Results of models linking psychosocial functioning to daily digital screen engagement with adjustments for the control variables

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Type of Effect</th>
<th>$B$</th>
<th>$SE$</th>
<th>95% CI</th>
<th>Beta</th>
<th>$p^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV-Based Engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td></td>
<td>-0.078</td>
<td>0.004</td>
<td>[-0.069, -0.194]</td>
<td>-0.084</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Quadratic</td>
<td></td>
<td>-0.040</td>
<td>0.004</td>
<td>[-0.033, -0.207]</td>
<td>-0.181</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Device-Based Engagement</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td></td>
<td>-0.073</td>
<td>0.004</td>
<td>[-0.081, -0.064]</td>
<td>-0.088</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Quadratic</td>
<td></td>
<td>-0.041</td>
<td>0.003</td>
<td>[-0.048, -0.034]</td>
<td>-0.222</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

*Notes.* Linear and parabolic relations were tested while controlling for variability linked to control variables. CI = Confidence Interval.
Table 4. Trends in psychosocial functioning for engagement levels below and above the observed extrema

<table>
<thead>
<tr>
<th>Predictor and engagement level</th>
<th>Extremum</th>
<th>B</th>
<th>SE</th>
<th>95% CI</th>
<th>Beta</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV-Based Engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below Extremum</td>
<td>1 hr 02 min</td>
<td>0.061</td>
<td>0.019</td>
<td>[0.024, 0.099]</td>
<td>0.022</td>
<td>0.001</td>
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<tr>
<td>Above Extremum</td>
<td></td>
<td>-0.138</td>
<td>0.01</td>
<td>[-0.157, -0.119]</td>
<td>-0.104</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Device-Based Engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below Extremum</td>
<td>1 hr 19 min</td>
<td>0.133</td>
<td>0.021</td>
<td>[0.174, 0.060]</td>
<td>0.047</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Above Extremum</td>
<td></td>
<td>-0.131</td>
<td>0.008</td>
<td>[-0.115, -0.184]</td>
<td>-0.104</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Notes. Linear relations were tested while controlling for variability linked to control variables. CI = Confidence Interval.