The Role of Different Screen Media Devices, Child Dysregulation, and Parent Screen Media Use in Children's Self-Regulation

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Author Note

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Abstract

Higher television exposure has been repeatedly linked to poorer self-regulation among young children. Recent studies show use of mobile screen media devices is also negatively related to self-regulation in early childhood. Despite the proliferation of mobile devices in households with young children, it is unclear whether children's use of smartphones and tablets predicts their self-regulation independently of television use and parents' screen media use or when also considering evocative effects of children's dysregulation. This multi-method, cross-sectional study with a racially diverse sample (N = 72) in the western U.S. examines parents' (86.3% mothers) leisure media use and preschool-aged children's (M = 38.02 months, 55.6% girls, 47.2% racial-ethnic minority) mobile media use, television use, and dysregulation as predictors of their behavioral battery-assessed self-regulation. As hypothesized, path models show the amounts of children's mobile media use, television use, and dysregulation negatively predict their self-regulation, and mobile media use is a stronger predictor than television use. We conclude with future directions to yield stronger inferences of screen media effects on child development that can inform interventions and screen time guidelines.

Keywords: screen time, mobile media, television, self-regulation, early childhood

Word count: 8,931 words

Statements of Public Significance: This study shows that preschool-aged children's screen time on mobile devices, such as tablets and smartphones, is more negatively related to their self-regulation than their television use. Children's earlier self-regulatory deficits and parental screen time were mostly unrelated to their media use, and their self-regulation was unrelated to parents' screen time. As young children are increasingly exceeding screen time guidelines, these findings encourage parents and other caregivers to limit children's screen media use in early childhood.

The Role of Different Screen Media Devices, Child Dysregulation, and Parent Screen Media Use in Children's Self-Regulation

Self-regulation in childhood is a powerful predictor of health, wealth, and well-being across the lifespan (Fergusson et al., 2013; Moffitt et al., 2011). A large literature links children's poor self-regulation to excessive or age-inappropriate television use (Barr et al., 2010; Lillard & Peterson, 2011). The rapid adoption of mobile screen media devices, or "mobile devices," in households with young children and their increasing screen time (Chen & Adler, 2019; Rideout, 2017) have inspired recent studies that show preschool-aged children's use of smartphones and tablets is negatively related to their self-regulation (McNeill et al., 2019; Nathanson & Beyens, 2018). The portability and interactivity of mobile devices afford young children greater agency in their screen media use than television. Most studies, however, focus on only one type of screen media device or do not differentiate or compare types, so it is unclear whether mobile device and television use independently predict children's self-regulation to a different extent.

In addition, parent and child media use with similar devices are positively related to each other (Lauricella et al., 2015; Tang et al., 2018), so parents' media use may predict children's self-regulation. Although contributions of parenting to child self-regulation are well-established (Eisenberg et al., 2005), associations between parents' media use and children's self-regulation have remained untested. As far as we know, there also have been no formal tests of whether parents' media use and children's dysregulation are related to each other, despite evidence that young children's self-regulatory and socioemotional difficulties predict their later media use (Radesky et al., 2014, 2016). This study thus considers children's dysregulation while comparing their mobile media use, television use, and parents' media use as predictors of self-regulation.

Researchers previously identified a child dysregulation profile that combines parent-rated

attention problems, aggression, and anxious/depressed symptoms and is conceptually distinct from self-regulation (Geeraerts et al., 2015; Kim et al., 2012). Whereas dysregulation reflects children's persistent self-regulatory deficits in everyday contexts, self-regulatory tasks assess children's capacity to deliberately control attention, emotion, and behavior. Performance-based tasks assess cognitive abilities under supervised and structured conditions, while questionnaires yield more ecologically valid data by assessing children's actual behavior in their natural environments, often without explicit guidance or structure (Toplak et al., 2013). In this study, self-regulation reflects children's potential or ability, whereas dysregulation reflects self-regulatory deficits children express as attentional, behavioral, and socioemotional difficulties in their daily lives. Although self-regulation and dysregulation are interrelated, they are more than the inverse of each other as dysregulation reflects real environmental conditions in a child's life.

Past studies have relied on parent-reported self-regulation *and* media use (Nathanson & Beyens 2018; Radesky et al., 2014) or few self-regulatory tasks (e.g., Nathanson et al., 2014), but batteries of developmentally appropriate, sensitive tasks assess self-regulatory capacity more objectively and comprehensively to provide less biased tests of its relations with parent-reported media use. Therefore, this multi-method, cross-sectional study extends knowledge in this area by directly comparing parents' reports of their own leisure media use, preschool-aged children's mobile media use, television use, and dysregulation as predictors of children's behavioral battery-assessed self-regulation in a diverse sample of mostly two-parent middle-class families.

The Development of Self-Regulation and Screen Media Use in Early Childhood

Rothbart (2007, p. 207) defines *effortful control* as the temperament-based self-regulatory ability to "choose a course of action under conditions of conflict," plan, and detect errors. Individual differences in effortful control, or self-regulation for simplicity's sake, are first

measurable in late infancy and remain moderately stable across childhood (Kochanska et al., 1996). The development of self-regulation in childhood is supported by warm and responsive parenting and positive parent–child interactions (Eisenberg et al., 2005). Studies of mostly television have linked children's self-regulatory difficulties to their amount of screen media use (Barr et al., 2010; Lillard & Peterson, 2011), which is concerning as young children's average daily screen time in the U.S. more than doubled from 1997 to 2014 (Chen & Adler, 2019).

While moderate amounts of media use and child-directed or educational content have been shown to be benign or even beneficial for children (Mares & Pan, 2013; Rasmussen et al., 2016), heavy media use is linked to low levels of self-regulation (Nathanson et al., 2014) and more symptoms of attention-deficit/hyperactivity disorder (Christakis et al., 2004). Displacement theory posits that media use comes at the cost of formative experiences (Anderson & Kirkorian, 2015), which in early childhood are parent–child interactions through which children learn to self-regulate (Kirkorian et al., 2009; Radesky et al., 2015). This evidence is mostly based on cross-sectional studies of child television exposure, so we limit use of causal language, and we focus on the amounts of screen time rather than the contents of family screen media use.

Television. Research linking preschoolers' high media use to poor self-regulation has largely focused on television to the exclusion of other devices (e.g., Nathanson et al., 2014). Following displacement theory (Anderson & Kirkorian, 2015), screen media can be powerful distractors during parent–child interactions (Anderson & Evans, 2001), as infants follow parents' lead when looking at screens, looking longer and more often following their gaze (Demers et al., 2013). Adult-oriented background television reduces the quality and quantity of parent–child play (Kirkorian et al., 2009) and verbal exchanges (Pempek et al., 2014), thereby disrupting and displacing parent–child interactions that promote children's development of self-regulation.

Similarly, young children's solitary play, which often occurs in a room where a television is on (Masur & Flynn, 2008), can be disrupted by television's attention-distracting properties (Schmidt et al., 2008). Habituation to such disruptions may be linked to the development of attention control, a component of effortful control responsible for focusing and shifting attention (Rothbart, 2007). Indeed, children's heavy television exposure is related to disrupted attentional processes (Christakis et al., 2004). Thus, studies show a negative link between television use and self-regulation in early childhood, but it is unclear whether children's mobile media use is related similarly to self-regulation because these existing studies did not also consider mobile devices.

Mobile Devices. Nationally representative U.S. data show 98% of children aged 8 and under live in a home with a mobile device, and 42% of young children own a tablet compared to less than 1% in 2011 (Rideout, 2017). Although young children averaged over two hours of screen time a day from 2011 to 2017, their mobile media use grew from 4% to 35% of their total screen time (Rideout, 2017), which reached nearly 2.5 hours per day in 2020 (Rideout & Robb, 2020). Thus, children's mobile media use has grown both in pervasiveness and total screen time.

Several studies report negative relations between young children's mobile media use and self-regulation. McNeill and colleagues (2019) found preschoolers who spent over 29 min a day on mobile apps scored lower than those who used apps 1 to 29 min a day on a computerized test of inhibitory control, a component of effortful control responsible for suppressing inappropriate responses (Rothbart, 2007). These findings were not replicated with television, when comparing app users to non-users, or with other tests of executive functions, which are higher-order cognitive processes that facilitate self-regulation (McNeill et al., 2019). We found in our preschool-aged sample that self-regulation was inversely related to the amount of mobile media use but not use of traditional devices (i.e., television and computers combined); however, we did

not directly compare television to mobile devices (Lawrence et al., 2020). Thus, at least one study (i.e., McNeill et al., 2019) has found different associations between self-regulation and the amount of daily use of mobile devices vs. television, specifically.

There are several avenues in line with displacement theory (Anderson & Kirkorian, 2015) that may explain why mobile media use is related to self-regulation differently than television, despite children consuming television shows on mobile devices and more television overall (Rideout, 2017). Mobile devices are easier to bestow to children as a distraction or reward because of their portability, making them more likely to displace opportunities to learn from parents how to self-regulate both inside and outside of the home. Radesky and colleagues (2016) argue that mobile devices may be used as an "electronic pacifier" in lieu of parent scaffolding of children's self-regulation. With fewer learning opportunities, children may experience prolonged challenges modulating emotions and impulses that drive dysregulated states (e.g., tantrums). These findings suggest mobile media use may be negatively related to self-regulation, as well as positively related to dysregulation, more strongly than television because of its greater potential for independent use (Connell et al., 2015) and displacement of parent–child interactions critical to self-regulatory development (Radesky et al., 2015).

Another reason to expect mobile media to differ from television in its relation to self-regulation is its potential for interactivity. Aladé and colleagues (2016) found preschool-aged children's learning of measurement skills differed if they interacted with a touchscreen tablet or watched a non-interactive video. Children in the interactive condition performed best on a near transfer task highly like their learning experience. Li and colleagues (2018) found 4- to 6-year-olds showed reduced self-regulation after watching a video on a laptop, but those who played a game on a tablet showed no reduction. Huber and colleagues (2018) found 2- and 3-year-olds

who watched a cartoon on a tablet showed lower post-exposure self-regulation than those who played an educational app on a tablet. Choi and Kirkorian (2016) found young 2-year-olds learned best in a specific-contingency condition using a touchscreen, but this condition hindered older 2-year-olds' learning. This aligns with evidence that neural networks important for learning develop from ages 2 to 3, such that younger toddlers benefit more from interactive media than older toddlers who learn effectively by viewing screen media (Anderson & Davidson, 2019).

These experiments show benefits of mobile media's interactivity, but correlational studies of children's screen time suggest excessive media use is related to lower self-regulation, regardless of the content. Watching television is usually not as cognitively demanding as using interactive media, as their uses are related to distinct patterns of brain activation and learning that vary by age (Anderson & Davidson, 2019). Preschool-aged children may find the interactivity of mobile devices more rewarding and engaging than watching television, even when viewing television shows on mobile devices. This may make it especially difficult to stop using mobile media, adding to their excessive use and disruption of self-regulation. In our analyses, we briefly examine content differences between children's television and mobile media use prior to examining links between their amounts of use and self-regulation to rule out the possibility that their content matters more for self-regulation than their screen time. Next, we consider the role of parents' media use and children's dysregulation in these associations with self-regulation.

Parents' Screen Media Use and Children's Dysregulation in Early Childhood

Parents shape young children's home media ecology by buying screen media devices, setting limits on child media use, and co-using or modeling media use to children, who in turn imitate their parents' modeled behavior in line with social learning theory (Bandura, 1978; Tang et al., 2018). Although studies have linked parents' leisure media use to children's use of

television and mobile devices (Carson et al., 2015; Lauricella et al., 2015), they have not examined parents' media use in relation to children's dysregulation or self-regulation. The child dysregulation profile includes anxious/depressed symptoms (Geeraerts et al., 2015), which have been directly linked to fathers' problematic media use (McDaniel & Radesky, 2018), so parent media use may be related to both child dysregulation and disrupted parent–child interactions in keeping with displacement theory (Radesky, 2015). We expect parent media use to be positively related to child media use and dysregulation and to negatively predict self-regulation.

Parents also report using mobile devices to calm and quiet their toddlers with heightened socioemotional difficulties (Radesky et al., 2016). In a nationally representative U.S. sample, infants with early, persistent, or worsening self-regulatory difficulties viewed more screen media by age two than those with fewer difficulties (Radesky et al., 2014). Both studies used children's parent-reported media use *and* self-regulation, so their estimated links included single informant bias and common method variance. These findings highlight the importance of accounting for evocative effects of child dysregulation on media use when testing whether media use predicts self-regulation and using different methods to measure these constructs. Dysregulation predicts worse socioemotional functioning and performance on self-regulatory tasks (Geeraerts et al., 2015; Kim et al., 2012), so we expect child dysregulation to negatively predict self-regulation and to be positively related to television use, mobile media use, and parents' media use.

The Current Study

It is unclear whether parents' media use and children's mobile device and television use predict their self-regulation differently or when considering evocative effects of dysregulation. This cross-sectional study with multi-method data extends the literature by 1) assessing children's self-regulation with a 10-task behavioral battery that far outnumbers past studies in

this area, 2) examining parents' and children's media use in relation to children's parent-reported dysregulation and child self-regulatory performance, and 3) directly comparing children's mobile device and television use in predicting self-regulation. We hypothesize that children's mobile media use (H1), television use (H2), dysregulation (H3), and parents' media use (H4) will negatively predict self-regulation, and children's mobile media use will predict self-regulation more strongly than television (H5). We expect parent and child media use and dysregulation to each be positively related to each other (Lauricella et al., 2015; Radesky et al., 2016), and for findings to remain when accounting for child age, gender, parent education, and family income (Rideout, 2017). We also consider content differences between children's use of mobile devices and television to ensure they do not confound comparisons of their links to self-regulation.

Material and Methods

Participants

Seventy-three preschool-aged children (M_{age} = 38.01 months, *SD* = 4.48; 54.8% girls) and at least one of their parents (M_{age} = 36.61 years, *SD* = 3.84; 86.3% mothers; 93.2% married) participated. For 10 families (13.7%) in which both parents completed questionnaires, only mothers' data are reported, because they generally spend more time than fathers on caregiving duties (Geiger et al., 2019). One-third of parents attained up to a master's degree, 30.1% attained a doctoral or professional degree, and 30.1% earned up to a college degree. For annual household income: 56.9% of parents reported over $100,000; 13.9% reported $80,000–$100,000; 13.9% reported $60,000–$80,000; 6.9% reported $40,000–$60,000; 1.4% reported $20,000–$40,000; and 6.9% did not report income. Most parents (78.1%) spoke English as their primary language at home, 9.6% spoke multiple languages, and the remaining spoke a language other than English.

Children were excluded if they were not native English speakers, had developmental

disabilities, severe health conditions, physical disabilities, or cognitive deficits. One child was excluded because of these criteria. The final sample included 72 children (M_{age} = 38.02 months, *SD* = 4.51, age range: 31.74–46.72 months; 55.6% girls). Parents identified 13.9% of children as being of Hispanic/Latino ethnicity, 61.1% White, 26.4% Biracial or Multiracial, 6.9% Asian or Asian American, 2.8% African American or Black, and 2.8% as "other." Overall, 52.8% were non-Hispanic White and 47.2% were racial-ethnic minorities. There were four pairs of twin siblings and one pair of non-twin siblings, so 67 unique families were in the final sample.

Procedure

Families with typically-developing children between 32 and 47 months of age were recruited from a lab school, preschools, daycare centers, local events, and via flyers posted throughout a suburban city with a large university in the western U.S. Parents were screened for eligibility by email or phone and scheduled for 90-min research visits between July 2016 and January 2019. Children and their parent(s) visited an on-campus research laboratory with a large "living room" and a small "game room," each with an adjacent observation room behind a two-way mirror. All procedures were approved by the university's Institutional Review Board, and parents' informed consent and children's assent were obtained before data collection.

During visits, each parent in attendance completed questionnaires in separate rooms,[1] while a researcher assessed the child's self-regulation in the game room. Sixteen parents (22.22%) completed questionnaires in the game room during at least part of the child assessment, but children's self-regulatory performance did not differ based on whether a parent was in the room with them for part, all, or none of the assessment, $F(2, 69) = 0.61$, $p = .547$. Parents were compensated with a $25 gift card and children received small prizes for participating.

[1] Ten families reported screen media use data online after their visit due to its later addition to the study.

Measures

Self-Regulation. Ten tasks were adapted from Kochanska and colleagues' (1996) effortful control behavioral battery to assess multiple self-regulatory skills in young children. Video recordings were later scored by at least three trained coders ($\kappa = .87$; Choe, 2021). *Effortful attention* tasks utilize age-appropriate Stroop-like stimuli to assess children's ability to inhibit a dominant response and instead provide one prescribed by the examiner; children were instructed in Snow/Grass (Carlson & Moses, 2001) and Day/Night (Gerstadt et al., 1994) to point to pictures that represented opposites of given verbal prompts. *Inhibition/initiation* tasks invoke turn-taking: Tower required children to take turns with the examiner in building a tower with blocks. *Voice modulation* was measured with Whisper; children were shown cards featuring popular cartoon characters and instructed to only whisper characters' names. *Fine and gross motor control* tasks included: Walk-a-Line Slowly, where children walked along the length of a 6-ft ribbon at regular speed and then twice at slow speed; Drawing, where children drew a line connecting cartoon trees on a piece of paper quickly and then slowly; and Turtle/Rabbit, where children moved rabbit and turtle figures along a winding path quickly and slowly, respectively. *Delay tasks* require children to delay gratification and included Dinky Toys, where children had to wait until the examiner gave permission to select a reward, and Gift Wrap and Gift Delay, where the examiner told children not to peek while they wrapped a gift and then not to touch it while the examiner stepped out of the room for three min under the guise of searching for a gift bow. Task scores were standardized and averaged together to create a total score ($\alpha = .71$).

Screen Media Use. Parents reported screen media device ownership, their own media use, and the amount of time, content, and context of children's exposure to screen media by device (e.g., television, tablet, smartphone). For this study, average weekly amounts of media use

for parents' leisure purposes and both mobile device and television use for children are reported. This measure asks parents to consider the last 30 days and indicate "about how many hours on the average weekday does your child view/use [device]" for each device in the home; this question was repeated for weekend/vacation days. Responses to these two questions were used to create weighted weekly averages for mobile devices (i.e., smartphone, tablet) and television, as is often done in other studies (e.g., Radesky et al., 2014). Parents estimated "about how many hours a day of [their] leisure time do [they] view/use [screen media devices]" on weekdays and weekends, which we aggregated into a weighted weekly average score of their leisure media use.

Parents reported children's favorite shows, games, and/or apps for each device. Content items were assigned scores for educational quality from zero ("not educational") to five ("most educational") and age recommendations based on Common Sense Media's ratings of educational value (i.e., 0-5 for specific learning objectives, age-appropriate challenges, potential for learning transfer, created with educators, and/or supported by research) and the minimum age for which the content is developmentally appropriate, respectively (http://www.commonsensemedia.org/www.commonsensemedia.org). Two research assistants collected these data and disagreements were resolved by consensus with the second author. Of the 144 unique items listed by parents, only 124 (79.17%) items were scorable, as some parents provided vague descriptions or reported content not listed by Common Sense Media. Only 15 items (12.10%) were interactive apps, and the remainder were identified as non-interactive media. We created mean scores for educational quality and age recommendations for television as well as for tablets and smartphones combined.

Child Dysregulation. Parents reported children's symptoms over the past two months on the Child Behavior Checklist Ages 1.5–5 using a 3-point response scale: 0 = Not True, 1 =

Somewhat or Sometimes True; 2 = Very True or Often True (Achenbach & Rescorla, 2000). The Attention Problems (5-item $\alpha = .62$), Aggressive Behavior (19-item $\alpha = .88$), and Anxious/Depressed (8-item $\alpha = .78$) syndrome scales were aggregated to create a child dysregulation profile that serves as a marker of developmental risk for persistent self-regulatory deficits and exists separately from specific disorders (Geeraerts et al., 2015). Raw scores from these scales' items were summed to create a total score of child dysregulation (32-item $\alpha = .89$).

Demographic Covariates. Parents reported their highest level of educational attainment [1 = partial high school, 8 = doctoral or professional degree], annual household income [1 = under $20,000, 6 = over $100,000], and information on their child, such as age in months and gender (-1 = girls, 1 = boys) on a demographics survey designed by the research team.

Data Analysis Plan

Descriptive statistics, correlations, missing data, and comparisons of the screen media content across devices were examined using SPSS 25 in preliminary analyses (IBM Corp., 2017). Study hypotheses were tested in path models using *Mplus* 8 structural equation modeling (SEM) software (Muthén & Muthén, 2018). Compared to regression, SEM possesses fewer assumptions, tests all relations among variables simultaneously, and estimates missing data with full-information maximum likelihood (FIML), which is better than other missing data techniques as it retains all cases and information to yield unbiased parameter estimates and standard errors (Acock, 2012; Kline, 2016). In line with conventions (Boomsma, 2000; Kline, 2016), results included model χ^2, comparative fit index (CFI), estimated root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). CFI > .90 reflects reasonably good fit. RMSEA ≤ .05 reflects close approximate fit, between .05 and .08 reflects reasonable error of approximation, and ≥ .10 reflects poor fit. SRMR < .90 reflects

sufficient fit. Sensitivity analyses gauged the robustness and replicability of the findings.

Results

Preliminary Results

Table 1 shows descriptive statistics and intercorrelations. Among 58 (80.56%) parents who completed all media questions, 57 parents reported owning at least one screen media device with an average of 10.31 (*SD* = 7.30, range = 0 to 28) hours of leisure media use per week. Fifty-seven parents reported owning a mobile device, with 56 owning a smartphone and 42 owning a tablet. According to parents, only 40 children (70.17% of children in households with mobile devices) used mobile devices on average 3.94 (*SD* = 3.93) hours per week with a weekly average of 2.87 (*SD* = 4.07, range = 0 to 20) hours of tablet use and 1.31 (*SD* = 1.98, range = 0 to 8) hours of smartphone use. Forty-five parents owned a television and 44 children watched television an average of 9.58 (*SD* = 11.52, range = 0 to 68) hours per week. Skewness (2.82) and kurtosis (11.32) values for television use suggested a non-normal distribution that we corrected with a $\log^{10}$ transformation.

Little's (1988) missing completely at random (MCAR) test was significant, $\chi^2(44) = 63.31$, $p = .030$, so missing data were related to measured variables. Missingness related to other variables is missing at random (MAR), and FIML can estimate unbiased parameters with these variables added to the model (Acock, 2012; Kline, 2016). Children missing child media data ($n = 16$) differed from those with media data ($n = 56$) on gender, $p = .004$, and dysregulation, $p = .012$. Girls and less dysregulated children were more likely to be missing media data. Children missing parent media data ($n = 14$) differed from children with these data ($n = 58$) on gender, $p = .002$, dysregulation, $p = .044$, and age, $p = .023$. Girls, less dysregulated children, and older children were more likely to be missing parent media data. All other variables were missing no

values or only one value, except family income in which five cases differed from cases with income data (n = 67) on child mobile media use, p = .025, self-regulation, p < .001, parent education, p = .028, and gender, p = .038. Children with more mobile media use, lower self-regulation, less educated parents, and girls were more likely to be missing income data. Child age, gender, parent education, and family income were related to missing data and other study variables, which supported their inclusion as covariates.

We used paired sample t-tests to compare mean scores for the educational quality and age recommendations of media content reported for television and mobile devices (see supplemental Table 1 for descriptive statistics of reported content items). Mean scores for educational quality did not differ between television and mobile devices, $t(15) = 0.67$, p = .515. Mean scores for age recommendations also did not differ between television and mobile devices, $t(15) = -0.97$, p = .346. We found no content differences between children's television and mobile media use, which justified our comparison of their amounts of screen time on these devices in path models.

Main Results

We initially tested hypotheses that children's mobile media use (H1), television use (H2), dysregulation (H3), and parents' media use (H4) negatively predict self-regulation in a fully saturated path model regressing self-regulation on our four main predictors, while estimating their intercorrelations. Unexpectedly, all correlations failed to reach significance, except a marginal correlation between parent media use and child television use. We removed all other correlations to increase power in a trimmed model that explained 40% of variance in children's self-regulation and fit the data well: $\chi^2(5) = 3.75$, p = .586, CFI = 1.00, RMSEA = .00 [.00, .14], SRMR = .06. Children's mobile media use negatively predicted their self-regulation (β = -.42, p < .001), as we previously found using regression analyses in Lawrence et al. (2020). Not

reported elsewhere, children's self-regulation was negatively predicted by their television use (β = -.37, p = .001) and dysregulation (β = -.28, p = .005) but positively predicted by parents' media use (β = .25, p = .027), while accounting for a marginal correlation between parent media use and child television use (r = .27, p = .075). These findings supported our first three hypotheses but refuted the fourth.

To test whether children's mobile media use predicts their self-regulation stronger than television (H5), we constrained paths from mobile media and television use to self-regulation to be estimated as the same value. We then used a chi-square difference (χ^2diff) test to compare this constrained model to the trimmed model, indicating whether constraining these paths to equality altered model fit and whether path estimates significantly differed from each other (Kline, 2016). The constrained model fit the data adequately: $\chi^2(6) = 8.03$, p = .236, CFI = 0.89, RMSEA = .07 [.00, .18], SRMR = .07 (see Supplemental Figure 1); however, fit was significantly worse than in the trimmed model, χ^2diff(1) = 4.28, p = .039. Thus, supporting our fifth hypothesis, children's mobile media use negatively predicted their self-regulation more strongly than television use.

Child age, gender, parent education, and family income were added to the trimmed model as covariates to reduce confounds and potential issues with missing data. Figure 1 shows our final model explained 49% of variance in self-regulation and was an excellent fit. Children's greater mobile media use, television use, and dysregulation predicted worse self-regulatory performance, further supporting our first three hypotheses. The path from parents' media use to children's self-regulation was marginally significant and positive, contrary to our fourth hypothesis. Child age was related to self-regulation (β = .27, p = .004) and gender (r = -.34, p = .006). Boys were younger than girls while older children showed better self-regulation. Paths from mobile media and television use to self-regulation differed in magnitude, albeit marginally,

χ^2diff(1) = 3.36, p = .067. Children's mobile media use predicted self-regulation (β = -.45, p < .001) more strongly than television use (β = -.34, p = .002), supporting our fifth hypothesis.

In sensitivity analyses, we re-ran the final model only with families with all media data (n = 55). The main differences from the final model were that child dysregulation and parent media use no longer predicted self-regulation (see Supplemental Figure 2). We also re-ran the final model only with mothers (n = 62) and replicated paths to self-regulation from mobile media use, television use, and dysregulation (see Supplemental Figure 3). Simulation studies show path models can yield sufficient power with samples as small as 50 or 100 cases if a parametric bootstrap method of resampling is used rather than FIML (Mooijaart & van Montfort, 2004). We replicated all paths from child media use to self-regulation with 1000 bootstrap draws. Because of its lower sample size demands, we also replicated results in a regression analysis in SPSS 25. Child mobile media use (β = -.44, p < .001), television use (β = -.37, p = .004), dysregulation (β = -.27, p = .024), age (β = .29, p = .019), and parent media use (β = .26, p = .041) predicted self-regulation, $F(8, 45) = 4.74$, $p < .001$, $R^2 = .46$. Post-hoc power analyses in G*Power 3.1 showed a sample size of 72 cases provided sufficient power (.80) in a regression analysis to detect moderate-to-large effect sizes of main predictors with or without covariates (Faul et al., 2009). In sum, when only including families with all media data and using regression or path modeling, we repeatedly found child mobile media and television use independently predicted self-regulation.

Discussion

To our knowledge, this is the first study to directly compare preschool-aged children's mobile media use, television use, dysregulation, and parents' media use as predictors of self-regulation. Children's greater mobile media use, television use, and dysregulation independently predicted their poorer self-regulatory performance when accounting for parents' media use and

demographic covariates. Surprisingly, parent media use positively predicted child self-regulation in some analyses. Parents' media use and children's dysregulation, however, were modest and inconsistent predictors of children's self-regulation in comparison to children's media use, and children's mobile media use was a stronger predictor than television use of their self-regulation.

Children's Use of Different Devices and Dysregulation Predict Self-Regulation

In support of our first three hypotheses, children's high mobile media use, television use, and dysregulation predicted poor self-regulation, supporting findings linking child self-regulation to mobile media use (McNeill et al., 2019; Nathanson & Beyens, 2018) *or* television exposure (Barr et al., 2010; Lillard & Peterson, 2011). We previously found a negative link between screen time and self-regulation driven by children's combined use of tablets and smartphones rather than separate uses of mobile devices (Lawrence et al., 2020). The current study extends these findings by directly comparing mobile devices to television and showing that mobile media use is a stronger predictor of self-regulatory performance, supporting our fifth hypothesis. These findings differ from evidence that high amounts of mobile app use, but not television viewing or any other type of media use, predict preschool-aged children's lower inhibitory control on a computerized "Go/No-Go" test (McNeill et al., 2019). Our behavioral battery may have yielded greater variance in self-regulation to be explained by both television and mobile screen time, as we found no educational quality or age recommendation differences in children's television and mobile media content. We lacked the data needed to determine the amount of time children interacted with mobile devices or used them in a non-interactive manner, as well as other aspects of content, such as pacing and realism. In another study of our sample, we found the content of children's television and mobile media use were unrelated to their self-regulation and primarily consisted of non-interactive television content (Lawrence et al., in preparation). This suggests the

general amount rather than the content of preschool-aged children's media use is related to their self-regulatory ability.

Inhibitory control enables children to suppress emotions and impulses in pursuit of goals and internalize family rules and societal norms (Kochanska et al., 1996). Consistent with displacement theory (Anderson & Kirkorian, 2015), children's mobile media use may interfere with parent–child interactions that support the development of self-regulation. Due to their convenience and portability, parents may come to rely on mobile devices to distract or down-regulate children's emotions and impulses (Radesky et al., 2016). Kabali and colleagues (2015), for example, reported that most parents allowed their young child to play with mobile devices so they could perform chores, keep their child calm in public, complete errands, and other reasons that extend beyond television viewing at home. Because mobile devices can play television shows, are portable, and are easy to bestow to children, we expected and found that children's amount of mobile media use is more negatively related to their self-regulation than television.

Children's independent use of mobile devices may also explain their stronger link to self-regulation than television. We expected parents' and children's media use to be positively related to each other, but only parents' leisure media use and children's television use were interrelated. Parents are more likely to co-use television than tablets or smartphones (Connell et al., 2015), so they may have considered co-viewing television with children as their own leisure media use. Preschoolers use mobile devices more for playing games or watching videos for fun than for educational purposes, and most 3- and 4-year-olds can use mobile devices without help (Kabali et al., 2015). These findings suggest children are less likely to co-use mobile devices with their parents than television, which may compromise their self-regulation because parents are less able to scaffold children's beneficial use of mobile devices.

Beyond associations between children's media use and self-regulation, we considered evocative effects of children's dysregulation, because self-regulatory deficits have been linked to television and video watching in early childhood (Radesky et al., 2014, 2016). In this study, parents rated children's dysregulation as deficits in everyday life over the last two months, while self-regulation was assessed with tasks in a controlled setting. The small association between dysregulation and self-regulation in this study supports their conceptual distinction and evidence that preschoolers' dysregulation predicts their worse performance on self-regulatory tasks (Geeraerts et al., 2015). Thus, child dysregulation predicted poorer self-regulatory capacity.

Contrary to expectations, children's dysregulation was unrelated to their media use, despite mobile media and television use predicting self-regulation. Studies show that children's dysregulated behavior evokes or is an immediate consequence of media use (Munzer et al., 2020; Radesky et al., 2014, 2016). Our measure of dysregulation included attention problems, aggression, and anxious/depressed symptoms, which may explain why it was unrelated to child media use. We know of no evidence linking media use to anxiety or depression in preschoolers, and media use's links to aggression and attention problems at this age are not specific to device type, but rather, screen time and content (Beyens et al., 2018; Christakis et al., 2004). While accounting for self-regulatory difficulties, children's media use predicted their self-regulatory performance, suggesting evocative effects of dysregulation were not a confound in this study.

Parents' Screen Media Use and Children's Self-Regulation and Dysregulation

Contrary to our fourth hypothesis, parent leisure media use positively predicted child self-regulation but not when accounting for covariates or using a reduced sample or bootstrap method. Because there was no bivariate relation between these variables, we refrain from speculating on whether parents' media use promotes children's self-regulation. Moreover, we

found no evidence that parent media use is related to child dysregulation, despite McDaniel and Radesky (2018) reporting that parents' problematic media use predicts greater disruptions in mother–child interactions, which then predict children's greater internalizing and externalizing symptoms. The term "technoference" reflects digital and mobile media use's daily disruptions to parent–child interactions (McDaniel & Radesky, 2018), and may explain whether parents' media use contributes to dysregulation and self-regulation, in part by shaping children's media use.

Following social learning theory (Bandura, 1978), parents' screen media use during meals and maternal modeling of media use are positively linked to young children's media use (Tang et al., 2018). Lauricella and colleagues (2015) found that children's media use was positively related to parents' use of the same type of device and parents' favorable attitudes toward media use. Parents who were heavy tablet users reported that their children spent more time using tablets, and this was most pronounced for parents with favorable attitudes toward mobile devices. We did not assess disruptive media use or parents' attitudes toward media use, which may explain our mixed findings linking parent and child media use and self-regulation.

Limitations, Strengths, and Future Directions

This cross-sectional study's small sample warrants cautious interpretation of its findings. A larger sample would yield greater power; yet we consistently replicated links between child media use and self-regulation in sensitivity analyses. Our modest sample size allowed us to administer 10 tasks, which far exceeds other studies, for a broader assessment of self-regulation. A sample covering the full socioeconomic and racial-ethnic spectra would clarify our findings' generalizability, as we mainly assessed parents with high education and income, as well as families identified as non-Hispanic White. Over 50% of parents reported having a graduate degree and annual household income over $100,000, and more educated parents reported less

leisure media use. Our findings may not generalize to families with fewer resources, so future studies should include more diverse samples. Longitudinal studies can yield stronger evidence of the direction of effects between media use and self-regulation, particularly evocative effects of dysregulation and mediational pathways from parent to child media use and self-regulation.

Parents could have misreported media use in our screen media survey, although they may be more accurate in early childhood than later as parents are around their preschoolers more often and in greater control of their media use. The 1-month reporting window also likely did not evoke strong memory biases. Our survey did not differentiate receptive versus interactive media use, parents' media use by device type, or overlap in child and parent media use. Although future studies can extend our findings by differentiating parents' use of distinct devices for all purposes in addition to leisure, our survey prioritized children's use of different screen media devices. Objective assessments of children's and parents' use of screen media devices, such as passive sensing apps and ecological momentary assessments, will be key advances in future studies.

Conclusions and Implications

The American Academy of Pediatrics recommends parents limit 2- to 5-year-olds' screen time to one hour a day and help children understand what they witness and apply what they learn from screen media (Reid Chassiakos et al., 2016). Children are exceeding screen time guidelines (Chen & Adler, 2019), which may hinder development of self-regulation and related abilities. Both children's screen media use and problematic media use have increased during the COVID-19 pandemic (Eales et al., 2021), suggesting that excessive media use and its disruptive effects have further worsened in recent years, possibly amplifying the associations found in this study.

Of notable concern are screen media's effects on children's language skills and executive functions (Anderson & Subrahmanyam, 2017; Lawrence & Choe, 2021), deficits in which are

reliably linked to poverty exposure (Noble et al., 2005). Children from low-income households consume over an hour more screen media per day than their affluent peers (Rideout, 2017); their media use starts at a younger age, increases with age more rapidly, and their tablet use becomes more popular than watching television during the preschool years (Kabali et al., 2015). Poverty exposure worsens children's risk of dysregulation (Johnson et al., 2011) and may increase their vulnerability to screen media effects. Fortunately, early childhood interventions and curricula hold promise in leveraging screen media devices to promote children's cognitive development, as illustrated by a growing literature (Aladé et al., 2016; Anderson & Davidson, 2019; Choi & Kirkorian, 2016; Schacter & Jo, 2016). Self-regulatory skills are malleable to intervention, and children with delayed development of self-regulation benefit most from computerized cognitive training (Diamond & Lee, 2011). Future research is necessary to understand the conditions under which, and the processes through which, screen media influences self-regulation, and to explore how media use can be designed and leveraged to support healthy development and well-being.

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Declaration of interest statement

The authors of this study have no conflicts of interest.

References

Achenbach, T. M., & Rescorla, L. A. (2000). *Manual for the ASEBA Preschool Forms and Profiles*. Burlington, VT: University of Vermont Department of Psychiatry.

Acock, A. C. (2012). What to do about missing values. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbooks in psychology®. APA handbook of research methods in psychology, Vol. 3. Data analysis and research publication* (pp. 27–50). American Psychological Association. https://doi.org/10.1037/13621-002

Aladé, F., Lauricella, A. R., Beaudoin-Ryan, L., & Wartella, E. (2016). Measuring with Murray: Touchscreen technology and preschoolers' STEM learning. *Computers in Human Behavior, 62,* 433–441. https://doi.org/10.1016/j.chb.2016.03.080

Anderson, D. R., & Davidson, M. C. (2019). Receptive versus interactive video screens: A role for the brain's default mode network in learning from media. *Computers in Human Behavior, 99,* 168–180. https://doi.org/10.1016/j.chb.2019.05.008

Anderson, D. R., & Evans, M. K. (2001). Peril and potential of media for infants and toddlers. *Zero to Three, 22*(2), 10–16.

Anderson, D. R., & Kirkorian, H. L. (2015). Media and cognitive development. In L. S. Liben, U. Müller, & R. M. Lerner (Eds.), *Handbook of child psychology and developmental science: Cognitive processes* (7th ed., pp. 949–994). John Wiley & Sons Inc. https://doi.org/10.1002/9781118963418.childpsy222

Anderson, D. R., & Subrahmanyam, K. (2017). Digital screen media and cognitive development. *Pediatrics, 140*(s2), S57–S61. https://doi.org/10.1542/peds.2016-1758C

Bandura, A. (1978). Social learning theory of aggression. *Journal of Communication, 28*(3), 12–

29. https://doi.org/10.1111/j.1460-2466.1978.tb01621.x

Barr, R., Lauricella, A., Zack, E., & Calvert, S. L. (2010). Infant and early childhood exposure to adult-directed and child-directed television programming: Relations with cognitive skills at age four. *Merrill-Palmer Quarterly, 56*(1), 21–48. https://doi.org/10.1353/mpq.0.0038

Boomsma, A. (2000). Reporting analyses of covariance structures. *Structural Equation Modeling, 7*(3), 461–483. https://doi.org/10.1207/S15328007SEM0703_6

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development, 72*(4), 1032–1053. https://doi.org/10.1111/1467-8624.00333

Carson, V., Stearns, J., & Janssen, I. (2015). The relationship between parental physical activity and screen time behaviors and the behaviors of their young children. *Pediatric Exercise Science, 27*(3), 390–395. http://dx.doi.org/10.1123/pes.2014-0214

Chen, W., & Adler, J. L. (2019). Assessment of screen exposure in young children, 1997 to 2014. *JAMA Pedia*trics, *173*(4), 391–393. doi:10.1001/jamapediatrics.2018.5546

Choe, D. E. (2021). Curvilinear relations between preschool-aged children's effortful control and socioemotional problems: Racial-ethnic differences in functional form. *Child Psychiatry and Human Development, 52,* 693–708. https://doi.org/10.1007/s10578-020-01056-8

Choi, K., & Kirkorian, H. L. (2016). Touch or watch to learn? Toddlers' object retrieval using contingent and noncontingent video. *Psychological Science, 27*(5), 726–736. https://doi.org/10.1177/0956797616636110

Christakis, D. A, Zimmerman, F. J., DiGiuseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Pediatrics*, *113*(4), 708–713. https://doi.org/10.1542/peds.113.4.708

Connell, S. L., Lauricella, A. R., & Wartella, E. (2015). Parental co-use of media technology with their young children in the USA. *Journal of Children and Media, 9*(1), 5–12. http://dx.doi.org/10.1080/17482798.2015.997440

Demers, L. B., Hanson, K. G., Kirkorian, H. L., Pempek, T. A., & Anderson, D. R. (2013). Infant gaze following during parent–infant coviewing of baby videos. *Child Development, 84*(2), 591–603. https://doi.org/10.1111/j.1467-8624.2012.01868.x

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*(6045), 959–964. doi:10.1126/science.1204529

Eales, L., Gillespie, S., Alstat, R. A., Ferguson, G. M., & Carlson, S. M. (2021). Children's screen and problematic media use in the United States before and during the COVID-19 pandemic. *Child Development.* Advance online publication. https://doi.org/10.1111/cdev.13652

Eisenberg, N., Zhou, Q., Spinrad, T. L., Valiente, C., Fabes, R. A., & Liew, J. (2005). Relations among positive parenting, children's effortful control, and externalizing problems: A three-wave longitudinal study. *Child Development, 76*(5), 1055–1071. https://doi.org/10.1111/j.1467-8624.2005.00897.x

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Fergusson, D. M., Horwood, L. J., & Ridder, E. M. (2005). Show me the child at seven: The consequences of conduct problems in childhood for psychosocial functioning in adulthood. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 46*(8), 837–849. https://doi.org/10.1111/j.1469-7610.2004.00387.x

Geeraerts, S. B., Deutz, M. H. F., Deković, M., Bunte, T., Schoemaker, K., Espy, K. A., Prinzie, P., van Baar, A., & Matthys, W. (2015). The Child Behavior Checklist Dysregulation Profile in preschool children: A broad dysregulation syndrome. *Journal of the American Academy of Child and Adolescent Psychiatry*, *54*(7), 595–602. http://dx.doi.org/10.1016/j.jaac.2015.04.012

Geiger, A. W., Livingston, G., & Bialik, K. (2019). *Six facts about U.S. moms*. Pew Research Center. https://www.pewresearch.org/fact-tank/2019/05/08/facts-about-u-s-mothers/

Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3½ –7 years old on a Stroop-like day-night test. *Cognition*, *53*(2), 129–153. https://doi.org/10.1016/0010-0277(94)90068-X

Huber, B., Yeates, M., Meyer, D., Fleckhammer, L., & Kaufman, J. (2018). The effects of screen media content on young children's executive functioning. *Journal of Experimental Child Psychology*, *170*, 72–85. https://doi.org/10.1016/j.jecp.2018.01.006

IBM Corp. (2017). IBM SPSS Statistics for Macintosh, Version 25.0. Armonk, NY: IBM Corp.

Johnson, S. E., Richeson, J. A., & Finkel, E. J. (2011). Middle class and marginal? Socioeconomic status, stigma, and self-regulation at an elite university. *Journal of Personality and Social Psychology*, *100*(5), 838–852. https://doi.org/10.1037/a0021956

Kabali, H. K., Irigoyen, M. M., Nunez-Davis, R., Budacki, J. G., Mohanty, S. H., Leister, K. P., & Bonner, R. L. (2015). Exposure and use of mobile media devices by young children. *Pediatrics*, *136*(6), 1044–1050. https://doi.org/10.1542/peds.2015-2151

Kim, J., Carlson, G. A., Meyer, S. E., Bufferd, S. J., Dougherty, L. R., Dyson, M. W., Laptook,

R. S., Olino, T. M., & Klein, D. N. (2012). Correlates of the CBCL-dysregulation profile in preschool-aged children. *Journal of Child Psychology and Psychiatry, 53*(9), 918–926. https://doi.org/10.1111/j.1469-7610.2012.02546.x

Kirkorian, H. L., Pempek, T. A., Murphy, L. A., Schmidt, M. E., & Anderson, D. R. (2009). The impact of background television on parent–child interaction. *Child Development*, *80*(5), 1350–1359. https://doi.org/10.1111/j.1467-8624.2009.01337.x

Kline, R. B. (2016). Principles and practice of structural equation modeling (4th ed.). The Guilford Press.

Kochanska, G., Murray, K., Jacques, T. Y., Koenig, A. L., & Vandegeest, K. A. (1996). Inhibitory control in young children and its role in emerging internalization. *Child Development*, *67*(2), 490–507. https://doi.org/10.2307/1131828

Lauricella, A. R., Wartella, E., & Rideout, V. J. (2015). Young children's screen time: The complex role of parent and child factors. *Journal of Applied Developmental Psychology, 36*, 11–17. https://doi.org/10.1016/j.appdev.2014.12.001

Lawrence, A. C., & Choe, D. E. (2021). Mobile media and children's cognitive skills: A review. *Academic Pediatrics*, *21*(6), 996–1000. https://doi.org/10.1016/j.acap.2021.01.007

Lawrence, A. C., Fann, H., Choe, D. E., & Cingel, D. P. (in preparation). Young children's self-regulation and content of their screen media use.

Lawrence, A. C., Narayan, M., & Choe, D. E. (2020). Young children's use of mobile devices is associated with their self-regulation. *JAMA Pediatrics*, *174*(8), 793–795. doi:10.1001/jamapediatrics.2020.0129

Li, H., Subrahmanyam, K., Bai, X., Xie, X., & Liu, T. (2018). Viewing fantastical events versus touching fantastical events: Short-term effects on children's inhibitory control. *Child*

Development, 89(1), 48–57. https://doi.org/10.1111/cdev.12820

Lillard, A. S., & Peterson, J. (2011). The immediate impact of different types of television on young children's executive function. *Pediatrics, 128*(4), 644–649. https://doi.org/10.1542/peds.2010-1919

Mares, M.-L., & Pan, Z. (2013). Effects of Sesame Street: A meta-analysis of children's learning in 15 countries. *Journal of Applied Developmental Psychology, 34*(3), 140–151. https://doi.org/10.1016/j.appdev.2013.01.001

Masur, E. F., & Flynn, V. (2008). Infant and mother–infant play and the presence of the television. *Journal of Applied Developmental Psychology, 29*(1), 76–83. https://doi.org/10.1016/j.appdev.2007.10.001

McDaniel. B. T., & Radesky, J. S. (2018). Technoference: Parent distraction with technology and associations with child behavior problems. *Child Development, 89*(1), 100–109. https://doi.org/10.1111/cdev.12822

McNeill, J., Howard, S. J., Vella, S. A., & Cliff, D. P. (2019). Longitudinal associations of electronic application use and media program viewing with cognitive and psychosocial development in preschoolers. *Academic Pediatrics*, *19*(5), 520–528. https://doi.org/10.1016/j.acap.2019.02.010

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., Houts, R., Poulton, R., Roberts, B. W., Ross, S., Sears, M. R., Thomson, W. M., & Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693–2698. https://doi.org/10.1073/pnas.1010076108

Mooijaart, A., & van Montfort, K. (2004). Statistical power in path models for small sample

sizes. In K. van Montfort, J. Oud, & A. Satorra (Eds.), *Recent developments on structural equation models: Theory and applications* (pp. 1–11). Kluwer Academic Publishers.

Munzer, T. G., Miller, A. L., Wang, Y., Kaciroti, N., & Radesky, J. S. (2020). Tablet, toddlers, and tantrums: The immediate effects of tablet device play. *Acta Paediatrica*. Advance online publication. https://doi.org/10.1111/apa.15509

Muthén, L. K. & Muthén, B. (2018). Mplus User's Guide. Version 8.

Nathanson, A. I., Aladé, F., Sharp, M. L., Rasmussen, E. E., & Christy, K. (2014). The relation between television exposure and executive function among preschoolers. *Developmental Psychology*, *50*(5), 1497–1506. https://doi.org/10.1037/a0035714

Nathanson, A. I., & Beyens, I. (2018). The role of sleep in the relation between young children's mobile media use and effortful control. *British Journal of Developmental Psychology, 36*(1), 1–21. https://doi.org/10.1111/bjdp.12196

Noble, K. G., Norman, M. F., & Farah, M. J. (2005). Neurocognitive correlates of socioeconomic status in kindergarten children. *Developmental Science*, *8*(1), 74–87. https://doi.org/10.1111/j.1467-7687.2005.00394.x

Pempek, T. A., Kirkorian, H. L., & Anderson, D. R. (2014). The effects of background television on the quantity and quality of child-directed speech by parents. *Journal of Children and Media, 8*(3), 211–222. https://doi.org/10.1080/17482798.2014.920715

Radesky, J., Miller, A. L., Rosenblum, K. L., Appugliese, D., Kaciroti, N., & Lumeng, J. C. (2015). Maternal mobile device use during a structured parent–child interaction task. *Academic Pediatrics*, *15*(2), 238–244. https://doi.org/10.1016/j.acap.2014.10.001

Radesky, J. S., Silverstein, M., Zukerman, B., & Christakis, D. A. (2014). Infant self-regulation and early childhood media exposure. *Pediatrics*, *133*(5), e1172–e1178.

https://doi.org/10.1542/peds.2013-2367

Radesky, J. S., Peacock-Chambers, E., Zuckerman, B., & Silverstein, M. (2016). Use of mobile technology to calm upset children: Associations with social-emotional development. *JAMA Pediatrics*, *170*(4), 397–399. doi:10.1001/jamapediatrics.2015.4260

Rasmussen, E. E., Shafer, A., Colwell, M. J., White, S., Punyanunt-Carter, N., Densley, R. L., & Wright, H. (2016). Relation between active mediation, exposure to *Daniel Tiger's Neighborhood*, and US preschoolers' social and emotional development. *Journal of Children and Media*, *10*(4), 443–461. https://doi.org/10.1080/17482798.2016.1203806

Reid Chassiakos, Y., Radesky, J., Christakis, D., Moreno, M. A., Cross, C., & and Council on Communications and Media (2016). Children and adolescents and digital media. *Pediatrics*, *138*(5), e20162593. https://doi.org/10.1542/peds.2016-2593

Rideout, V. J. (2017). *The Common Sense Census: Media use by kids age zero to eight.* San Francisco, CA: Common Sense Media. https://www.commonsensemedia.org/sites/default/files/uploads/research/csm_zerotoeight_fullreport_release_2.pdf

Rideout, V., & Robb, M. B. (2020). *The Common Sense Census: Media use by kids age zero to eight.* San Francisco, CA: Common Sense Media. https://www.commonsensemedia.org/sites/default/files/research/report/2020_zero_to_eight_census_final_web.pdf

Rothbart, M. K. (2007). Temperament, development, and personality. *Current Directions in Psychological Science*, *16*(4), 207–212. https://doi.org/10.1111/j.1467-8721.2007.00505.x

Schacter, J., & Jo, B. (2016). Improving low-income preschoolers' mathematics achievement

with Math Shelf, a preschool tablet computer curriculum. *Computers in Human Behavior*, *55*(Part A), 223–229. http://dx.doi.org/10.1016/j.chb.2015.09.013

Schmidt, M. E., Pempek, T. A., Kirkorian, H. L., Lund, A. F., & Anderson, D. R. (2008). The effects of background television on the toy play behavior of very young children. *Child Development, 79*(4), 1137–1151. https://doi.org/10.1111/j.1467-8624.2008.01180.x

Tang, L., Darlington, G., Ma, D. W. L., Haines, J., & on behalf of the Guelph Family Health Study (2018). Mothers' and fathers' media parenting practices associated with young children's screen-time: A cross-sectional study. *BMC Obesity*, *5*(37), 1–10. https://doi.org/10.1186/s40608-018-0214-4

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry*, *54*(2), 131–143. https://doi.org/10.1111/jcpp.12001

Table 1

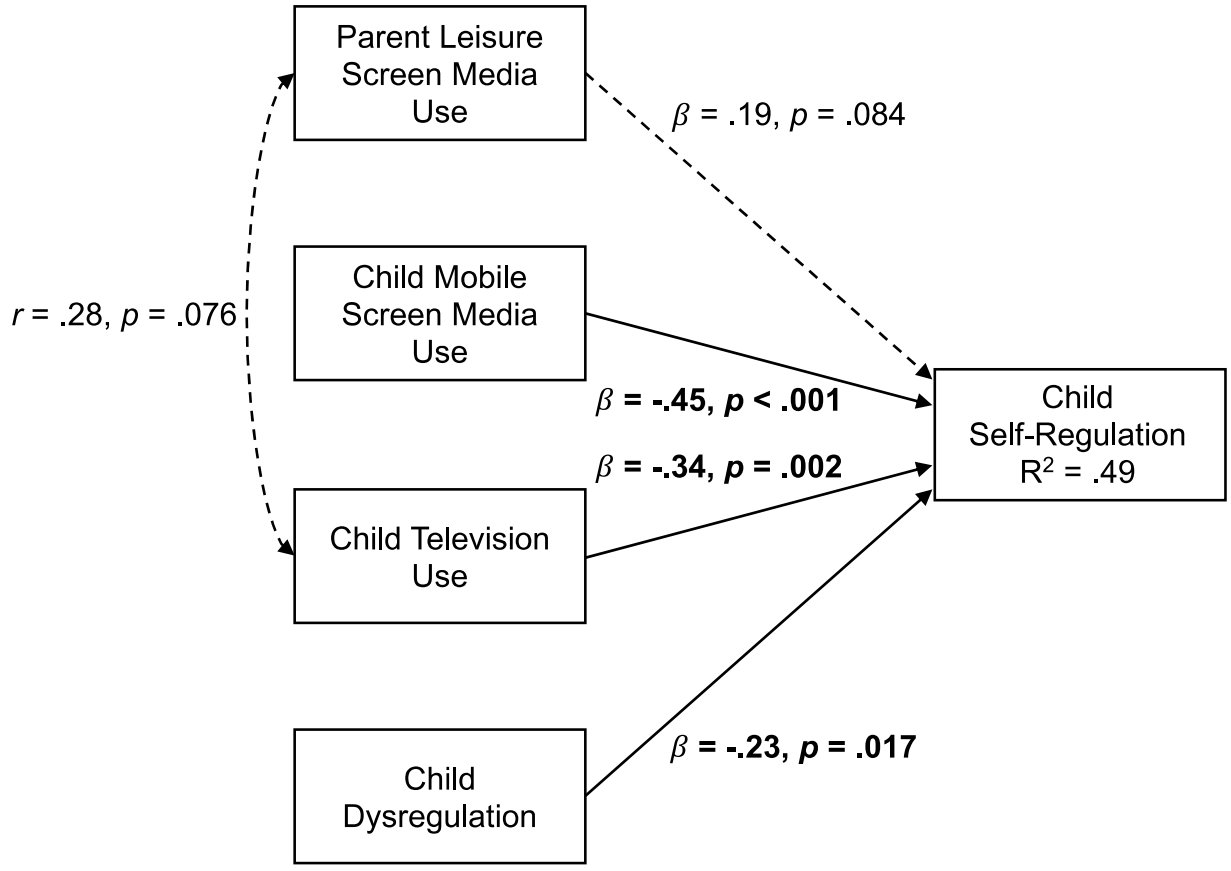
Descriptive Statistics and Intercorrelations of Study Variables

Variables	1	2	3	4	5	6	7	8	9
1. Child age in months	–								
2. Child gender	-.33**	–							
3. Parent education level	.01	.10	–						
4. Family income	.04	.07	.13	–					
5. Parent screen media use	.03	-.12	-.26*	-.03	–				
6. Child dysregulation	-.15	.19	.01	.18	.04	–			
7. Child television use	-.06	.23†	-.15	-.01	.27*	-.10	–		
8. Child mobile device use	.02	-.15	-.08	-.02	.23†	.07	-.09	–	
9. Child self-regulation	.36**	-.22†	.02	.01	.06	-.29*	-.26†	-.36**	–
M	38.02	-.11	6.86	5.27	10.31	12.85	1.82	3.94	-.02
SD	4.51	1.00	1.05	1.07	7.30	8.14	1.15	3.93	.52
N	72	72	71	67	58	71	56	56	72

Note. Child gender is coded -1 = girls and 1 = boys. †$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Figure 1

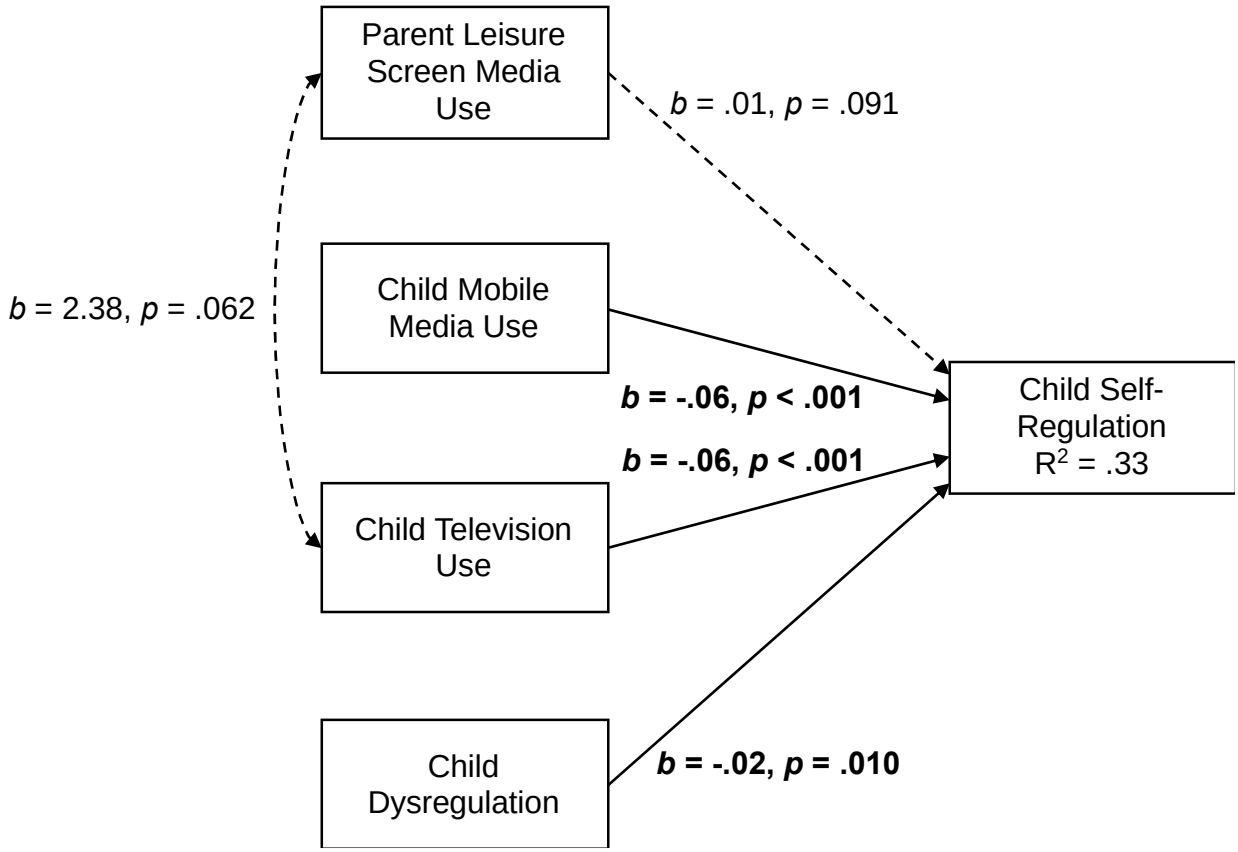
Final Model of Parent and Child Screen Media Use and Child Dysregulation as Predictors of Self-Regulation



Note. Model $\chi^2(7) = 3.83$, $p = .799$, CFI = 1.00, RMSEA = .00 [.00, .09], SRMR = .04. Child age, gender, parent education, and family income are covariates but are not shown for clarity.

Supplemental Figure 1

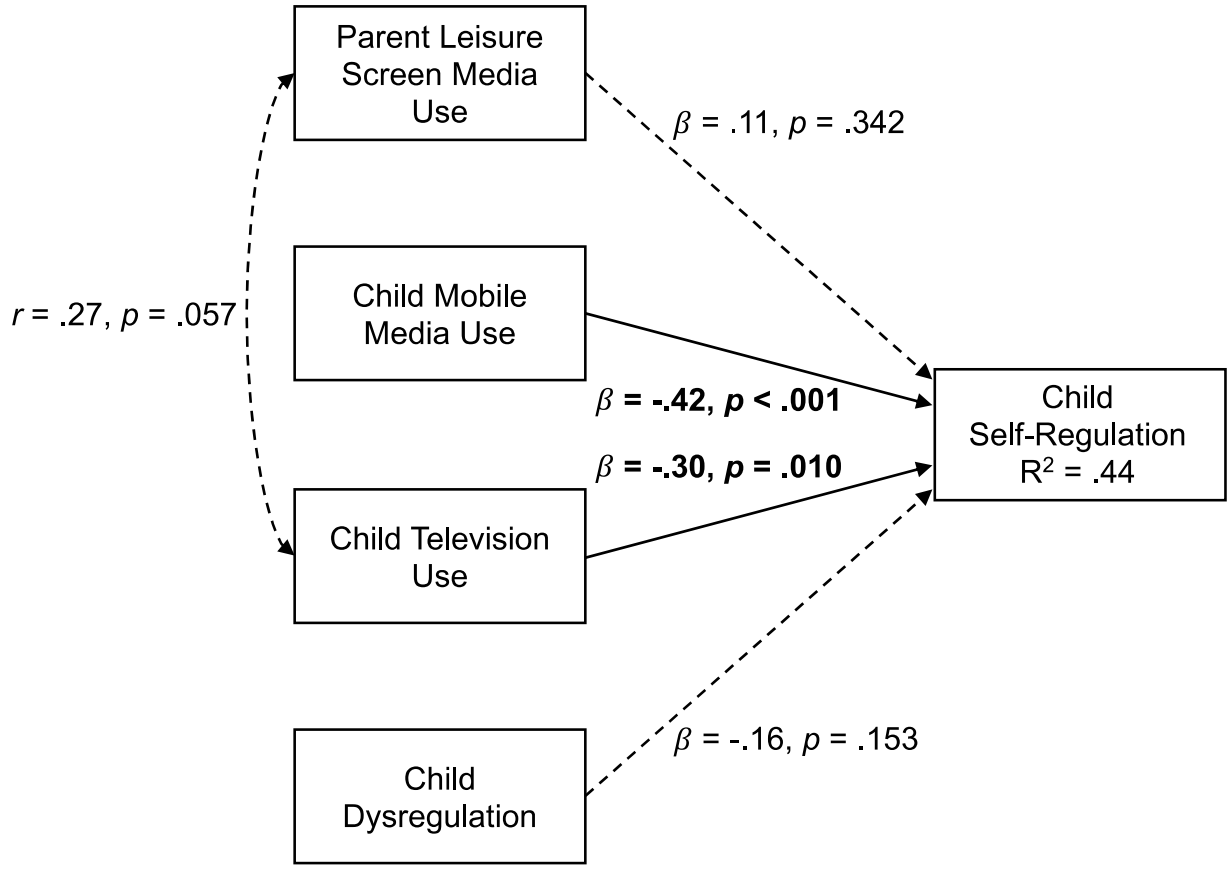
Constrained Model of Parents' Leisure Screen Media Use and Children's Mobile Media Use, Television Use, and Dysregulation as Predictors of Behavioral Battery-Assessed Self-Regulation



Note. Paths from children's mobile media use and television use to self-regulation are constrained to equality: model $\chi^2(6) = 8.03$, $p = .236$, CFI = .89, RMSEA = .07 [.00, .18], SRMR = .07. Unstandardized estimates are reported to clearly show paths estimated to equality.

Supplemental Figure 2

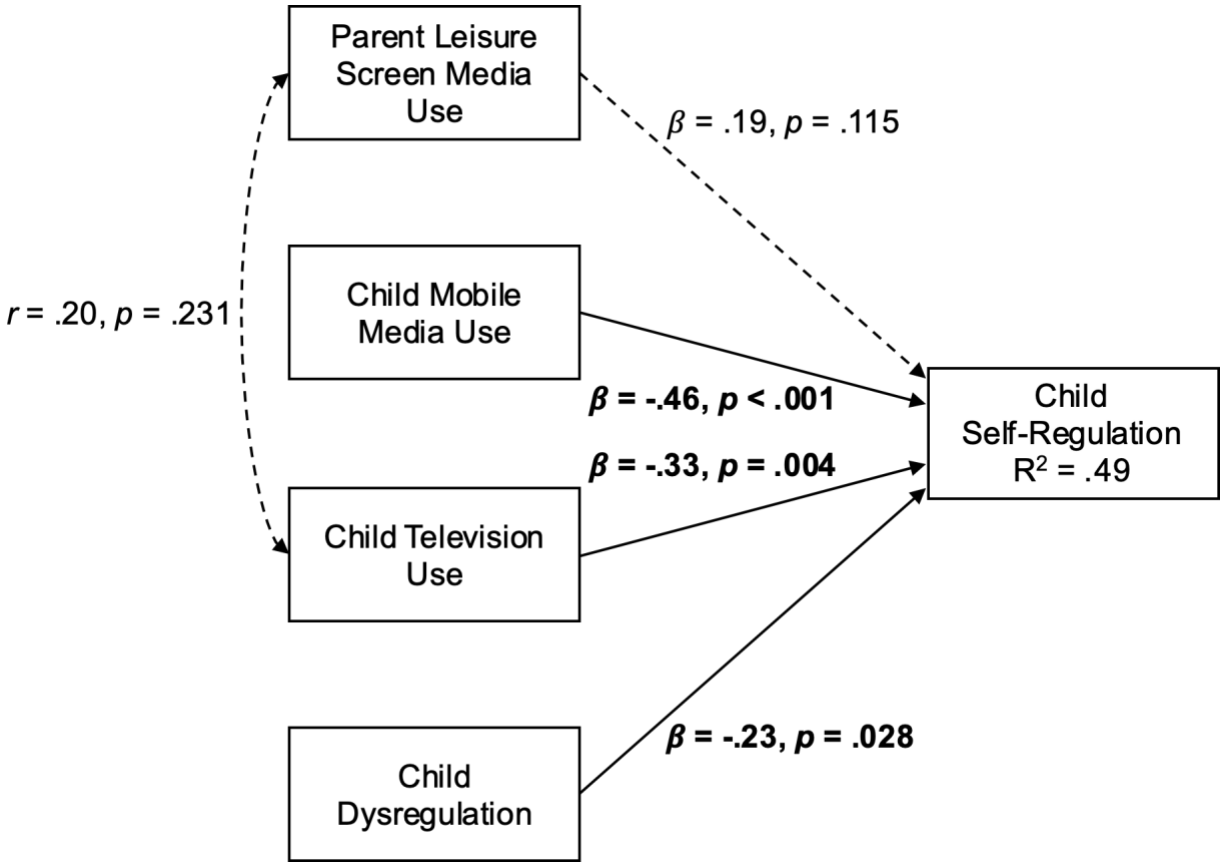
Final Model of Parents' Leisure Screen Media Use and Children's Mobile Media Use, Television Use, and Dysregulation as Predictors of Behavioral Battery-Assessed Self-Regulation



Note. Among only families with all SMU data (n = 55): model $\chi^2(7) = 6.25$, p = .511, CFI = 1.00, RMSEA = .00 [.00, .16], SRMR = .05. Child age, gender, parent education, and family income are covariates but are not shown for clarity. Child gender is related to age and television use, such that boys were younger and watched more television than girls. Child age is related to self-regulation, such that older children showed better self-regulation than younger children. Parent education is related to parent screen media use, such that parents with higher educational attainment reported less leisure screen media use.

Supplemental Figure 3

Final Model of Mothers' Leisure Screen Media Use and Children's Mobile Media Use, Television Use, and Dysregulation as Predictors of Behavioral Battery-Assessed Self-Regulation



Note. Among only families in which mothers participated in data collection (n = 62): model $\chi^2(7) = 4.21$, $p = .756$, CFI = 1.00, RMSEA = .00 [.00, .11], SRMR = .04. Child age, gender, parent education, and family income are covariates but are not shown for clarity. Child gender is related to age, such that boys were younger than girls. Child age is related to self-regulation, such that older children showed better self-regulation than younger children.