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Only So Many Hours in a Day: Early Childhood Screen Time in Boston and Mexico City

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According to the displacement hypothesis, screen media use might displace time children have to devote to other activities. In this study, we tested the displacement and related hypotheses, and explored how associations varied cross-culturally. We collected time-use diaries from 198 children in Boston, United States (U.S.), and Mexico City, Mexico. Comparing across research sites, children in Mexico City invested more time consuming media, while Boston children spent more time playing outdoors. In Boston, time spent using media was negatively associated with engagement in play and several other in-home activities, while in Mexico City, media use was positively associated with indoor activities like play. In both sites, media use and time spent outside were inversely related. We interpret these findings considering (a) the displacement and other competing hypotheses on the effects of media on children's time use and (b) known cultural/regional differences between the U.S. and Mexico.

Keywords: time use, early childhood, displacement hypothesis, screen time, international research

The first eight years of life are a sensitive period of development, during which a child's experiences have profound impacts on his or her intellectual growth and well-being later in life (Knudsen, Heckman, Cameron, & Shonkoff, 2006). Research inspired by economics conceptualizes children's time use as a commodity that can be "invested" in activities that facilitate development (Huston, Wright,

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Marquis, & Green, 1999). Extending this logic, the time children spend engaging in activities conducive to learning (e.g., play involving words and language) or healthy growth and development (e.g., physical play/exercise outdoors) might be developmentally beneficial investments, while consuming noneducational screen media might be less beneficial or even harmful (Huston et al., 1999; Mutz, Roberts, & van Vuuren, 1993). Historically, the notion that children's time using screen media displaces other activities has been a recurring concern (Neuman, 1995). The advent and popularity of television prompted studies exploring the relation between children's television viewing and time in other activities (e.g., Mutz et al., 1993). For example, one study found that children with access to television spent less time outside compared with peers without television access (Murray & Kippax, 1978). Work conducted at the turn of the 21st century has extended this line of inquiry to include access to interactive platforms, including computers and video gaming consoles (Hofferth, 2009). This more recent work found, for example, that time spent with computers and video games was inversely related to time spent playing (Hofferth, 2009). Over the decade since this topic was last researched, there has been a dramatic increase in the use of mobile media that children can consume "anytime, anywhere" (Rideout, 2017), as well as greater theoretical interest in cultural and regional factors that shape children's media use patterns (Jordan & Prendella, 2019).

In an era when children can move seamlessly between screens and the physical world, we investigated the associations between screen use and time engaged in activities believed to have a positive effect on early child development. Using parent-completed time-use diaries, we examined how time-use patterns of 2.5- to 8.0-year-old children varied as a function of cultural and regional differences in Boston, U.S., and Mexico City, Mexico. Our aim was to interpret patterns of children's time use in light of previously established hypotheses in this domain. Most prior studies in this area have been conducted in the U.S. (e.g., Huston et al., 1999) or in other English-speaking Western countries (e.g., Murray & Kippax, 1978), where there are mixed or negative attitudes around childhood screen use (Blum-Ross & Livingstone, 2016). Replicating this kind of research in the U.S. allows us to compare our data set to benchmarks from prior work. As far as we are aware, this topic has never been investigated in Mexico. In Mexico, public messaging around childhood screen use is less negative (Janssen, Medina, Pedroza, & Barquera, 2013), and environmental factors like pollution (Blake & Rowland, 1995) and crime in some cities (Overseas Security Advisory Council, 2017) might prompt families to spend more time indoors. Comparing such differing countries can provide insight into how universal or regionally and culturally driven children's time-use patterns might be.

Young Children's Time Use

Myriad unstructured time investments can positively influence young children's development. Several classic child development theories propose that children learn through playful interaction with their environments (e.g., Piaget, 1962). Playing in literacy-enriched spaces that include written labels, books, and writing instruments supports language development (Roskos & Neuman, 1998). Children derive further cognitive benefits from caregiver teaching, such as reading books (Mol, Bus, de Jong, & Smeets, 2008). Pretend play has been found to promote literacy, enhance reasoning, and reduce anxiety (Lillard et al., 2013). Toy play stimulates creativity (Lehrer, Petrakos, & Venkatesh, 2014). Physical play, from sports to "roughhousing," affords children opportunities to collaborate, follow directions, and control impulses (Tannock, 2014). Consistently getting optimal sleep is associated with improved executive functioning and verbal and nonverbal cognition and with decreased hyperactivity and conduct problems (Taveras, Rifas-

Shiman, Bub, Gillman, & Oken, 2017). Engaging in chores allows children to provide valuable aid to their families and practice empathy, caring, and cooperation (Roopnarine, 2011).

There have been repeating debates about whether and how the use of screen media may influence the time children have to engage in these other activities (Neuman, 1995). In the U.S. and in other Western countries, several hypotheses have been proposed to predict associations between screen time and other time investments. Below, we describe the most frequently invoked hypotheses in prior literature and ones that are feasible to assess with time-use diary data. Our study aims to assess the plausibility of each in present day Boston and Mexico City.

Displacement Hypothesis

Given the finite amount of time in a day, the displacement hypothesis proposes that the more time children spend with media, the less time they have to engage in other pursuits (Mutz et al., 1993). Sometimes this displacement can be relatively benign, such as children spending less time reading comic books after the family buys a new media device (Koolstra & van der Voort, 1996; Neuman, 1995). The closely related notion that children might use a new media device to meet a need or want (e.g., entertainment) previously fulfilled by a different activity has been termed the functional similarity/equivalence hypothesis (Huston et al., 1999; Mutz et al., 1993; Neuman, 1995). The functional similarity/equivalence hypothesis predicts that entertainment media directly replaces play because of their similar functions, but might be unrelated to doing chores or other functionally different activities.

Displacement raises concern that children will dedicate time to noneducational media that could be better spent engaging in more developmentally optimal activities like reading, studying, or sports (Huston et al., 1999; Neuman, 1995). Because media products are attractive, engaging, and do not necessarily require much cognitive, physical, or social exertion to use, some worry that children will choose to use media instead of pursuing activities that may require more effort and attention (Huston et al., 1999). If children spend less time in beneficial pursuits, their overall development may suffer (Neuman, 1995). Although these concerns are based on the debatable premise that children would gain more from a screen-free activity, the displacement hypothesis holds considerable face validity and is commonly invoked when considering the potential impact of media use on children's time.

Media-as-Default Hypothesis

The media-as-default hypothesis proposes that increased time spent with screen media may occur on days when children simply have more free time or have fewer alternative activities in which to engage (Huston et al., 1999). For example, children typically spend more time playing video games on the weekends compared with weekdays, when school and homework limit their leisure time (Huston et al., 1999). This hypothesis would predict that time spent with media and time engaged in activities like attending religious services might be inversely related.

The More, the More Hypothesis

Conversely, the more, the more hypothesis proposes that children who spend large amounts of time with media may also make time for many other activities (Mutz et al., 1993). In other words, active children may spend more time engaging with media and pursuing other activities relative to peers (Mutz et al., 1993). Consuming media may stimulate interest in related activities (Huston et al., 1999), such as a child asking to read an *Arthur* book after watching an episode of the *Arthur* television series (Fisch, 2004). Some children "multitask" when using media, engaging in multiple activities simultaneously. For example, it is well documented that while watching television, young children alternate their attention between the screen and playing with toys (e.g., Anderson & Lorch, 1983). Thus, media use may facilitate or positively relate to, rather than displace, other activities, especially those that tend to occur indoors, such as toy play or chores (Williams, 1986).

Comparing Children's Time Use Hypotheses

The research literature presents inconsistent evidence for and against the various time-use hypotheses. Murray and Kippax (1978) found positive associations between time spent watching television and playing in Australia and the U.K.—findings reproduced in the U.S. by Huston and team (1999). Conversely, Hofferth (2009) found that time spent with video games, computers, and television was associated with decreases in the amount of time U.S. children played and slept. In the same 2009 study, Hofferth discovered that playing video games and watching television had small but negative impacts on time spent reading, while time spent on the computer was unrelated to reading time. Focusing on a different portion of the same time-use data set, Vandewater, Bickham, and Lee (2006) found no relation between children's television viewing and reading time. Overall, the evidence is inconsistent about how media use is associated with other activities. The findings, however, are dated, representing a time before mobile devices were widely prevalent. Different patterns might be observed in the present era when screen time could potentially overlap with more nonscreen activities.

Importance of Cultural and Regional Differences

Although variations in associations between time using screens and time in other activities may be partially attributable to historical context (e.g., displacement functioning differently after a newer platform lost its novelty; Murray & Kippax, 1978; Mutz et al., 1993; Neuman, 1995), differences in cultural context also may play a role. Children's time use in general, and the displacement hypothesis in specific, have been examined in numerous international settings, including Australia (e.g., Murray & Kippax, 1978), Canada (e.g., Williams, 1986), the U.K. (e.g., Murray & Kippax, 1978), South Africa (e.g., Mutz et al., 1993), and the U.S. (e.g., Hofferth, 2009). In most cases, these studies examined time-use data within the context of a single culture. Theoretically, patterns of children's media use may vary as a function of differences of social context, cultural norms, and values (Jordan & Prendella, 2019).

In both the U.S. and Mexico, parents report ambivalent feelings about the impact of children's screen time on children's development and well-being, but attitudes are more positive in Mexico (see Migues, 2018). This distinction renders the U.S. and Mexico optimal for time-use comparison. In both countries,

there is a history of high-quality educational content for children (Fisch, 2004), with parents reporting that media can provide positive educational experiences (Rideout, 2017; Silver et al., 2019). However, enthusiasm about screen media's educational potential is counterbalanced in both regions by public concerns about a) screen time displacing other activities and b) children being exposed to immoral or otherwise harmful content when consuming screen media (Rideout, 2017; Silver et al., 2019). In the U.S., the American Academy of Pediatrics (AAP) and other authoritative professional organizations have urged parents to limit children's screen time (Schmidt, Bickham, Branner, & Rich, 2008). Comparable Mexican organizations have not issued similar recommendations (Janssen et al., 2013). More U.S. parents incorporate media into discipline or reward rituals (e.g., punishing a child by revoking screen privileges), than rely on media as a tool for bonding with, educating, or entertaining children (Wartella, Rideout, Lauricella, & Connell, 2014). In contrast, many Latino parents purchase electronic devices to encourage children to spend time at home with family (Halgunseth, Ispa, & Rudy, 2006) and use technology to connect with children when away from home (Migues, 2018). This occurs even though Mexican parents express concern that screens could interfere with family bonding (Migues, 2018; Silver et al., 2019). In both countries, most parents report establishing rules to limit children's screen time (Rideout, 2017; Silver et al., 2019), but children in Latin American countries watch television and play with electronic games for longer durations than peers in the U.S. (Janssen et al., 2013; Singer, Singer, D'Agostino, & DeLong, 2009).

Current Study

We explored children's activities across various domains in the mobile technology era, with a special emphasis on the associations between screen time and other activities. This is the first recent study in this topic area conducted in any country, and the first with data from Mexico. Parents of young children in Boston and Mexico City completed time-use diaries describing their children's days during the week and weekend. We were particularly interested in whether cultural factors might influence children's time-use patterns on a macro level, and how theories about children's time use established in the literature might explain observed patterns. Our study addressed the following questions:

RQ1: *How does young children's time use vary cross-culturally among children from Boston and from Mexico City?*

RQ2: *Which time-use hypothesis best explains the association between children's engagement with screen media and other activities? Does this vary cross-culturally?*

Method

Study Management and Ethical Review

The authors designed this study and coordinated overall organization, management, and data handling. The Boston Children's Hospital Institutional Review Board (IRB) approved the study structure and data management plans. For the Boston sample, recruitment was subcontracted to the market research firm Cambridge Focus, and data collection was subcontracted to the Center for Marketing Technology at Bentley University. The Bentley University IRB approved the Boston study protocol and materials. For the

Mexico City sample, market research firm 2-morrow engaged in recruitment, translated study materials into Spanish, and conducted data collection. Centro de Investigación en Ética Aplicada y Valores at Universidad Anáhuac review board approved the Mexico City protocol and materials. In both sites, the authors provided in-depth training to the researchers who conducted data collection.

Sample

Children ages 2.5–8.0 years and their parents were recruited to participate in this study. Both Cambridge Focus and 2-morrow recruited participants from databases of interested families that they established using flyers, social media postings, and word of mouth. Researchers called and conducted in-person visits of eligible database families to recruit participants. Families received US$100 in Boston and US$125 in Mexico for participating in the study.[3]

Recruitment yielded 327 families (Boston n = 146 and Mexico City n= 181). Of the 327 recruited families, 70 in Boston and 128 in Mexico City provided usable data in the form of at least one complete time-use diary, yielding a full sample size of 198. Both samples were of somewhat higher socioeconomic status than the general populations in each city. Children (49% female) ranged in age from 2.32 to 8.01 years (M = 5.29 years, SE = 0.11). Family and child demographics and technology access by site are presented in Table 1. Relative to the Mexico City sample, in Boston, children were younger, households were smaller and had greater access to computers and tablets, and parents were older and more highly educated.

Compared with the 129 families who consented to participate in the study but did not provide usable data (defined below), the 198 families in the final sample had younger primary caregivers (M = 33.94 years, SE = 0.41 vs. M = 36.34, SE = 0.59, $t(238.06) = 3.34$, $p = .001$) and owned fewer devices (M = 8.03 devices, SE = 0.18 vs. M = 8.80, SE = 0.29, $t(214.28) = 2.25$, $p = .026$). Families in Mexico City were more likely to provide complete time-use diaries than families in Boston (71% completion rate in Mexico City vs. 48% in Boston, $\chi 2(1) = 17.55$, $p < .001$).

[3] The market research firms in each country recommended compensation amounts that seemed ethical and appropriate given the nature of the data collection and the distance families needed to travel to participate in the training session.

Table 1. Means (SD) For and Percentages of Participants who Indicated Each Demographic Variable in Boston and Mexico City.

	Boston (n = 70)	Mexico City (n = 128)	Significance
Child age	4.83 (0.18)	5.54 (0.14)	$t(150.64) = -3.16^{**}$
Child sex	46% Female	51% Female	$\chi^2(N = 198, 1) = 0.47$
Child in school or childcare	87%	91%	$\chi^2(N = 198, 1) = 0.91$
Household size	3.91 (0.12)	4.48 (0.16)	$t(192.06) = -2.38^{**}$
Family composition			
One child	31%	36%	$\chi^2(n = 197, 1) = 0.46$
Target child + 1 sibling	43%	40%	
Target child + multiple siblings	26%	24%	
Parent age	36.04 (0.56)	32.78 (0.52)	$t(170.00) = 4.25^{***}$
Parent sex	89% Female	91% Female	$\chi^2(n = 197, 1) = 0.40$
Parent education			$\chi^2(n = 197, 3) = 36.38^{***}$
High school or less	4%	24%	
Some college	16%	17%	
College	43%	53%	
Post-college	37%	6%	
Parent marital status			$\chi^2(n = 197, 4) = 1.37$
Married	83%	84%	
Divorced or separated	9%	5%	
Never married	9%	11%	
Parent employment			
Primary caregiver employed	73%	66%	$\chi^2(n = 197, 1) = 0.94$
Secondary caregiver employed	94%	92%	$\chi^2(n = 195, 1) = 0.31$
Technology access			
Television	99%	100%	$\chi^2(n = 196, 1) = 1.81$
Computer	96%	82%	$\chi^2(n = 197, 1) = 7.53^{**}$
Video game console	64%	60%	$\chi^2(n = 196, 1) = 0.43$
Smartphone	100%	100%	N/A
Tablet	97%	87%	$\chi^2(n = 197, 1) = 5.16^{*}$

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

Procedure

Families participated in a two-week series of data collection events between April and June 2016 in Boston and in June 2016 in Mexico City. In both the U.S. and Mexico, parent-child dyads attended a study enrollment session where parents installed MetricWire (2016, MetricWire Inc., Ontario, CA), a data collection app compatible with both Android and iOS phones, onto their phones. A few parents who did not own smartphones compatible with MetricWire were lent iPod Touch devices to use during the study. On these devices, MetricWire was the only app available, and app download capability was disabled. Parents were trained on MetricWire app use and were provided a set of written instructions with visuals for future reference. As part of the enrollment session, parents completed a baseline questionnaire. The day following the enrollment session, parents began two weeks of intensive data collection in which they completed 24-hour time-use diaries and ecological momentary assessments of their child's play and media use. All these measures were intercorrelated, demonstrating convergent validity (Bickham, Scandurra, Powell, & Rich, 2017). In the present study, we focus solely on the time-use diary data to provide estimates of how much time children engaged in activities.

Time-Use Diaries

Over the course of the two-week study period, parents received four notifications from MetricWire to complete time-use diaries: one randomly chosen weekday and one randomly chosen weekend day in Week 1, and one random weekday and one random weekend day in Week 2. Parents received notifications to complete diaries at approximately 7:00 p.m. on each day and could complete them at any point before midnight.

Each diary template featured a matrix of a full 24-hour day divided into 15-minute intervals, beginning at 4:00 a.m. one day and ending at 4:00 a.m. the next. Parents noted the time that their child engaged in a given activity by selecting one or more intervals (e.g., if a child participated in an hour-long activity, the parent would select four 15-minute intervals).

For each selection, parents were prompted to complete a series of drop-down menus to characterize their child's time use. Parents indicated what their child was doing during the chosen time block: sleeping/resting, eating, in school, in religious activities, doing chores, reading, playing, or engaging in media use.[4] In each time block, parents could select multiple activities to denote what might be occurring simultaneously.

Play was defined for parents as "any activity that your child does for fun." If parents indicated that their child was playing, they could—but were not required—to specify characteristics of the play including whether it occurred indoors, outdoors, or both.

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[4] Parents could also report that their child was participating in an organized activity, self-care activity, shopping, special events, travel, or "other" activity. For the sake of brevity, we do not report on those activities in this study.

The diary prompted parents to think of children's television, computer, video game console, and mobile device use when considering their media use. If parents indicated that their child was using media, they could—but were not required—to specify the kind of content with which children were engaged. They could note that children were engaged in forms of media/technology use that we categorized as passive (watching television or movies on any digital device), interactive (playing games or looking at websites), communication-focused (e-mailing, texting, Skype), and/or school-focused.

Data Cleaning and Quality Checks

For a diary to be considered complete, at least 18 hours of the child's day must have been reported by parents. Following procedures used in prior time-use diary studies (e.g., Heymann, 2010; Hofferth, Davis-Kean, Davis, & Finkelstein, 1997), we edited diaries when incomplete information was provided. In 126 diaries, we manually added missing bouts of sleep when parents did not log the child's sleeping hours at the beginning and/or the end of the day (Heymann, 2010). In 23 diaries, parents indicated only when their child began activities, neglecting to denote activity end times. In these cases, we manually added end times, assuming one activity ended when the next began. Altogether, 198 parents provided 497 valid time-use diaries (253 weekday and 244 weekend diaries): 79 completed two weekday diaries, and 72 completed two weekend diaries.

After identifying our full data set, we conducted a further round of editing rules developed for the Panel Study of Income Dynamics ([PSID], Hofferth et al., 1997). In 152 diaries, parents reported time blocks of two or more hours where they noted children engaging in several distinct activities. For example, they might indicate that over a four-hour span, the child was eating, playing indoors, doing chores, and at a religious service. To adjust these blocks into more realistic time units, we subdivided the blocks of time by assuming meals lasted 30 minutes and travel lasted 45 minutes and dividing the remaining time evenly among all other activities, as per PSID protocol.

Analytic Approach

We summed the amount of time parents indicated their child engaged in each activity. To account for positive skew, we square-root transformed reported times before analyses. However, untransformed times in minutes are reported below for ease of reading and interpretation.

Main Models

We used generalized estimating equations (GEE) across our main analyses. As an extension of linear regression that is appropriate for data sets with nonindependent observations (Burton, Gurrin, & Sly, 1998), GEE allowed us to include all complete time-use diaries in our analyses while accounting for correlations between two diaries completed by the same participant. To address RQ1, which asked about cross-site differences in children's time use, we fit separate GEE models for the weekday and weekend diaries. Differences across research sites were examined, controlling for child age, school status, and gender; parent education, employment status, and age; and household size and device ownership. For RQ2, which asked about the relation between children's time with screens and engagement in other

pursuits, we added a total screen time[5] predictor and a screen time x research site interaction term to the GEE models from RQ1. This allowed us to assess whether screen time was associated with children's nonmedia activity engagement, and whether those relations varied across research sites.[6]

Robustness Check Models

As an exploratory robustness check, we alternatively sought to leverage the within-subjects variation among diaries provided by the subset of families with two complete weekday (n = 79) or weekend (n = 72) diaries. Displacement is commonly studied using cross-sectional correlational or regression methods similar to our GEE models, which conflate variation between and within individual children (Mutz et al., 1993). However, displacement-related hypotheses center around how increases in media use reorient an individual's time use, and therefore an analytical technique examining how increases in screen time impact time within individual children is more appropriate than one that focuses on differences in time use between children (Mutz et al., 1993). In our robustness models, we were able to compare whether individual children spent more or less time in other activities when their media use was higher or lower.

For families with two weekday and/or weekend diaries, we coded the diary during which children engaged in a greater amount of screen time as the higher media weekday or weekend, and the diary during which children spent less time with screens as the lower media weekday or weekend. Participants who engaged in the same amount of screen time on both weekday (n = 14) or weekend (n = 8) diaries were excluded. As expected, children spent significantly more time with media on higher media weekdays (M = 227.85 min., SD = 191.57 vs. M = 122.09, SD = 120.19; $t(78) = 9.43$, $p < .001$, partial $\eta^2 = 0.53$) and weekends (M = 313.75 min., SD = 219.95 vs. M = 162.50, SD = 126.36; $t(71) = 8.90$, $p < .001$, partial $\eta^2 = 0.53$).

We conducted a series of repeated measures Analysis of Covariance (ANCOVA) models. These explored whether time in each nonmedia category varied between higher and lower media days (within-subjects factor) and whether there was a day x research site interaction, indicating that associations between screen time and activity engagement varied within individuals across sites.

Sample included in robustness analyses

Relative to participants with only one valid weekday or weekend diary, in families with two diaries, secondary caregivers were likelier to be employed (97% vs. 89%, $\chi^2(1) = 4.01$, $p = .045$) and

[5] In alternate models, we substituted the general screen time variable with the more specific passive and interactive media use time variables. Overall, results were similar regardless of which of these three variables we used. Therefore, for simplicity's sake, we only report on the overall screen time composite.

[6] We ran each of these models twice, alternatively using Boston and Mexico City as the reference group to be able to assess whether associations were significantly different from zero for each site. In these models, the simple main effects revealed whether times were significantly different from zero within a single site, and the interaction terms revealed whether associations were significantly different between sites.

children were marginally older (M = 5.50, SE = 0.15 vs. M = 5.11, SE = 0.16; $t(196) = 1.72$, $p = .086$). There were no other differences between this subsample and the full sample.

Results

Differences in Overall Time Use Between Boston and Mexico City

In both locations, children spent most of their time sleeping/resting, in school, playing, or engaged with screen media (Table 2). Despite similarities in the relative ranks of various activities, the absolute amount of time spent in specific activities varied between the Boston and Mexico City samples. Children in Mexico spent more time engaged with screen media on both weekdays (a difference of 130.80 min) and weekends (141.65 min). Children from Mexico City engaged in more passive and interactive media use on both weekdays and weekend days, and more school-focused media on weekdays. The Mexico City sample also spent more time in chores on both weekdays and weekends (31.80 min. on weekdays and 16.20 min. on weekends), while Boston participants spent more of their playtime outdoors (49.48 min. on weekdays and 53.27 min. on weekends). Some differences between sites emerged for only one day type. Mexico City participants spent more time eating (38.77 min.) and playing (87.20 min.) on weekdays, while in Boston, participants spent more time sleeping on weekend days (39.56 min.).

Media and Other Activity Tradeoffs in Boston and Mexico City

Site Similarities in Time-Use Patterns

As shown in Figure 1, in both locations, a one-hour increase in screen time was associated with significant weekday decreases in school time. Likewise, a one-hour increase in screen time was associated with decreased outdoor playtime on weekend days in both sites (Figure 2).

Table 2. Marginal Mean Minutes (SE) that Children Engaged in Activities in Boston and Mexico City as Calculated through Generalized Estimating Equations.

	Weekday			Weekend		
	Boston (n = 53)	Mexico City (n = 116)	Wald χ^2	Boston (n = 61)	Mexico City (n = 112)	Wald χ^2
Sleeping/resting	671.73 (12.43)	632.18 (6.77)	6.25*	690.19 (11.26)	691.77 (10.99)	.01
Eating	96.12 (8.14)	134.89 (5.54)	12.41***	133.46 (8.70)	142.42 (5.50)	1.22
School	307.19 (25.14)	319.16 (12.43)	0.57	44.61 (13.18)	104.45 (14.87)	8.48**
Religious activity	1.79 (1.19)	-0.03[c] (0.45)	1.87	11.78 (5.02)	4.19 (1.86)	1.37
Chores	16.12 (5.33)	47.91 (5.57)	23.15***	23.25 (6.14)	39.45 (5.12)	5.74**
Reading	29.33 (5.95)	22.43 (3.59)	1.57	23.48 (5.74)	24.84 (5.63)	0.25
Play[a]	252.71 (23.34)	339.91 (20.47)	5.14*	421.77 (21.47)	389.75 (17.32)	1.91
Indoor	172.50 (18.65)	189.09 (11.48)	1.36	267.67 (18.09)	252.90 (14.85)	0.78
Outdoor	82.35 (9.94)	32.87 (5.34)	21.61***	145.39 (13.62)	92.12 (9.86)	15.65***
Media[b]	102.34 (14.71)	233.14 (14.71)	38.32***	138.36 (17.87)	280.01 (19.19)	21.77***
Passive	86.57 (15.25)	178.75 (14.17)	19.13***	112.37 (14.76)	222.53 (17.45)	16.52***
Interactive	25.39 (6.41)	44.43 (5.36)	3.95*	26.88 (10.48)	57.66 (8.47)	6.04*
Communication technology	0.68 (1.69)	4.03 (1.62)	2.20	1.89 (1.09)	1.71 (0.84)	0.01
School-focused	0.24 (1.09)	5.44 (1.68)	7.11**	0.09 (1.04)	4.40 (2.44)	2.64

Note. Times were square-root transformed in analyses to correct for deviations from normality but presented here as nontransformed for ease of interpretation.

[a] Parents sometimes noted that their child was playing without specifying if they were indoors or outdoors, and they occasionally noted that their children were playing both inside and outside within the same block. Accordingly, time engaged in indoor and outdoor play does not sum to the total amount of play.

[b] Parents sometimes indicated that, within a single block, their child was engaged in media multitasking, simultaneously engaging with devices in different ways. Accordingly, each media use category does not sum to the total amount of screen time. These analyses include data from the entire sample, regardless of whether families owned a given device.

[c] −0.03 is a marginal mean calculated via a GEE model with demographic controls. The raw mean is 0.19 min. (SE = 0.19).

[†] * $p < .05$. ** $p < .01$. *** $p < .001$.

Site Differences in Time-Use Patterns

Weekdays Only

In Boston only, there was a trending positive simple main effect for time spent engaged with media and with chores on weekdays, as shown in Figure 1. As screen time increased, so did time in chores. In Mexico City only, there were positive simple main effects for general and indoor play, such that as media use increased, so did time in play.

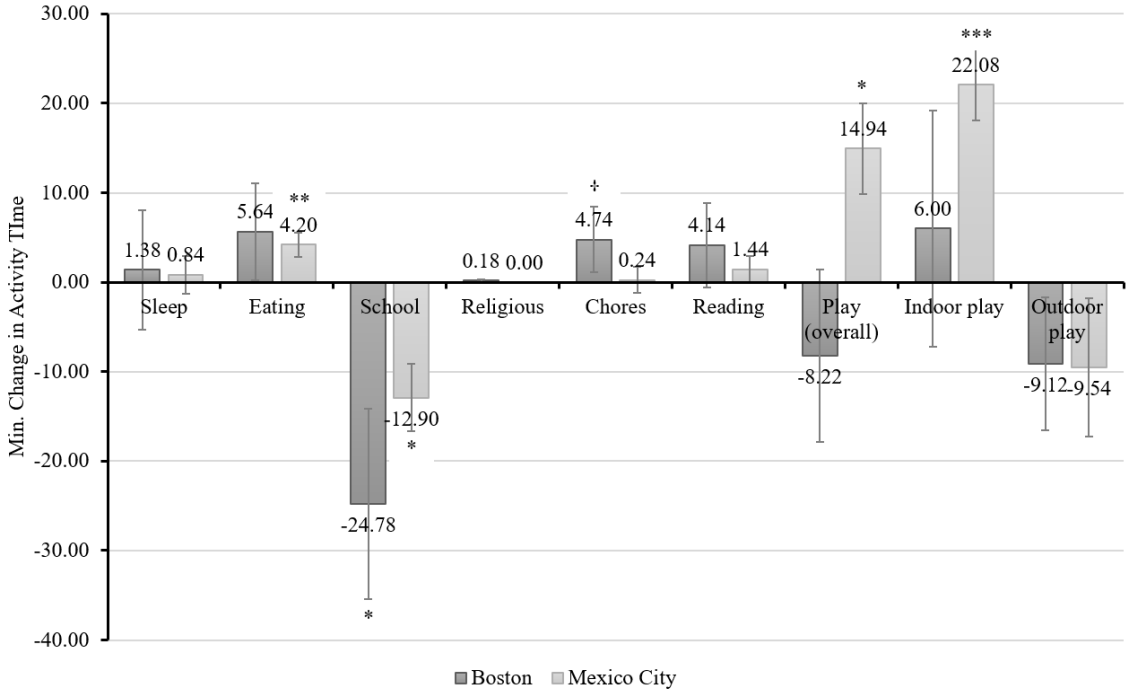

Figure 1. Number of minutes each activity increased or decreased following a one-hour increase in screen time on weekdays. Error bars represent standard errors. Times were square-root transformed in all analytical models to correct for deviations from normality, but estimates using nontransformed variables are presented here for ease of interpretation. † p < .10. * p < .05. ** p < .01. *** p < .001.

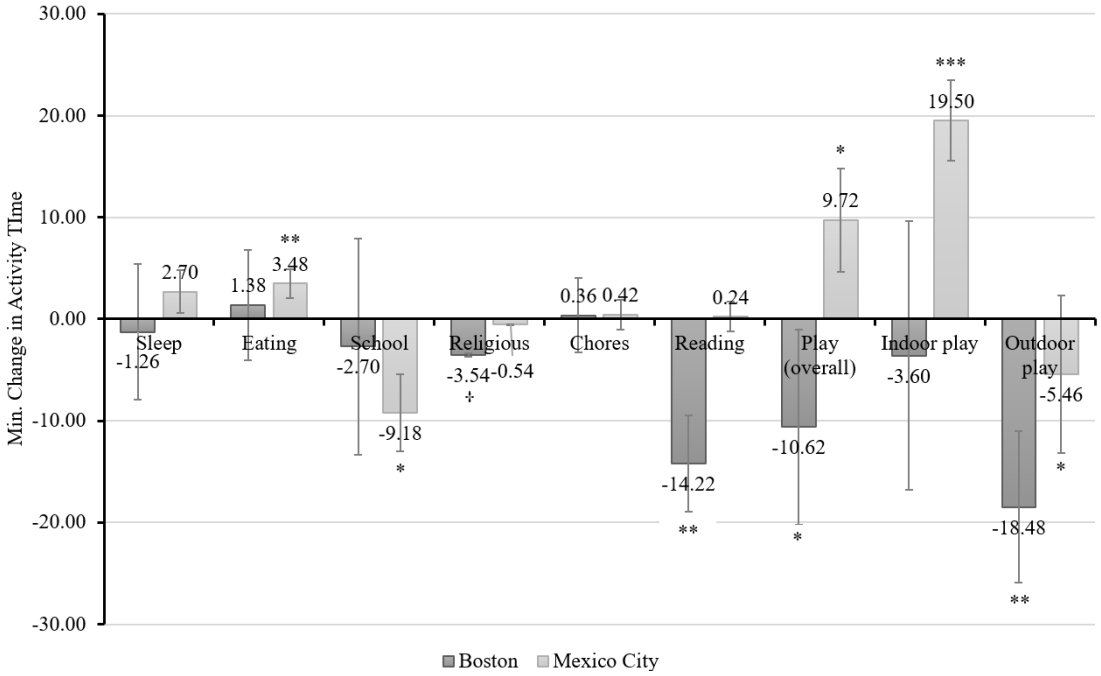

Figure 2. Number of minutes each activity increased or decreased following a one-hour increase in screen time on weekend days. Error bars represent standard errors. Times were square-root transformed in all analytical models to correct for deviations from normality, but estimates using nontransformed variables are presented here for ease of interpretation. † p < .10. * p < .05. ** p < .01. *** p < .001.

Weekends Only

On weekends, the association between screen time and time reading (Wald $\chi^2(1) = 7.08$, $p = .008$), playing generally (Wald $\chi^2(1) = 11.12$, $p = .001$), and playing indoors (Wald $\chi^2(1) = 12.42$, $p < .001$) were significantly different between Boston and Mexico City (i.e., there were significant interaction effects). See Figure 2. In Boston, as screen time increases, reading and overall play decrease (simple main effects). In contrast, in Mexico, as screen time increases, time in overall and indoor play also increases (simple main effects).

In Boston only, there was a trending simple main effect for weekend religious activities. As media time went up, time in religious activities went down.

Both Weekdays and Weekends

In Mexico City only, increases in screen time were associated with an increase in eating on both weekdays and weekends (simple main effects).

Robustness Checks

Results that partially replicate the main models

Indoor and overall play. The pattern of results in the repeated measures ANCOVAs comparing time use between higher and lower media days largely mirrored the findings of the main GEE models. There was continued evidence suggesting a diverging relation between screen time and play (indoor and overall play) in the two locations. We noted a significant day x research site interaction for weekend indoor play, $F(1,62) = 6.56$, $p = .013$, partial $\eta^2 = 0.096$. Post hoc tests revealed that in Mexico City, participants engaged in more indoor play on higher media weekend days (M = 285.00 min., SD = 166.29 vs. M = 207.81 min., SD = 147.18; $F(1, 40) = 5.69$, $p = .022$, partial $\eta^2 = 0.124$). There was a similar main effect on weekday indoor play ($F(1, 63) = 5.02$, $p = .029$, partial $\eta^2 = 0.074$), which was significant in post hoc analyses for only the Mexico City sample, $F(1, 48) = 7.98$, $p = .007$, partial $\eta^2 = 0.143$. Mexico City participants spent 182.45 min. (SD = 138.95) playing indoors on higher media weekdays, but only 124.29 min. (SD = 99.59) on lower media weekdays. There were no main or interaction effects for overall playtime, but we did note a significant finding in post hoc analyses. In Boston, participants spent more time engaged in overall play on lower media weekend days (M = 487.83 min., SD = 173.81 vs. M = 423.91 min., SD = 170.86; $F(1, 21) = 8.13$, $p = .009$, partial $\eta^2 = 0.270$).

Additional activities. There was a trending research site x day interaction for weekday eating, $F(1,63) = 2.88$, $p = .094$, partial $\eta^2 = 0.044$. Post hoc tests revealed that Mexico City participants ate more on higher media weekdays (M = 122.76 min, SD = 58.55) than lower media weekdays (M = 146.63 min, SD = 93.49), $F(1,48) = 3.80$, $p = .057$, partial $\eta^2 = 0.07$. This aligns with the GEE models, which found significant associations for both weekdays and weekend days. In the robustness models, there was a significant main effect for weekend religious activities ($F(1,62) = 5.30$, $p = .025$, partial $\eta^2 = 0.079$) and a trending main effect for weekday outdoor play ($F(1,63) = 3.34$, $p = 0.072$, partial $\eta^2 = 0.050$). In both cases, participants appeared to engage in more of each activity on lower media days, but in post hoc tests, associations were not significant in either location. In the GEE models, similar associations were significant for weekend religious activities in Boston and outdoor play in both locations. There was a significant main effect for weekend chores ($F(1,62) = 5.62$, $p = .021$, partial $\eta^2 = 0.083$), and a trending main effect for weekday chores ($F(1,63) = 3.22$, $p = .078$, partial $\eta^2 = 0.049$). Mexico City participants spent significantly more time with chores on higher media weekends (M = 44.63 min., SD = 54.03 vs. M = 30.73 min., SD = 59.62; $F(1,40) = 5.13$, $p = .029$, partial $\eta^2 = 0.114$), and there was a similar trend for weekdays (M = 64.59 min., SD = 98.18 vs. M = 41.33 min., SD = 52.90; $F(1,48) = 3.15$, $p = .082$, partial $\eta^2 = 0.062$). This differs somewhat with our GEE models, which found positive associations for the Boston sample only.

Results Unique to the Robustness Models

Despite many similarities, there were noteworthy differences between the robustness and GEE models. In the robustness models, we found no associations with time in school or reading. Although there were no overall main or interaction effects for sleep in the robustness models, we noted in post hoc tests that our Boston sample got considerably more sleep on lower than on higher media weekdays ($M = 710.63$ min., $SD = 73.05$ vs. $M = 679.69$ min., $SD = 65.66$, $F(1, 15) = 16.10$, $p = .001$, partial $\eta^2 = 0.518$).

Discussion

This study revisited the displacement and related time-use hypotheses (Neuman, 1995) in an era when interactive media devices are ubiquitous and cultural and regional differences are recognized as critical variables in behavioral science. To our knowledge, this is the first examination of the displacement or related hypotheses in Mexico. Overall time-use findings point to patterns that are largely insensitive to differences posed by macrolevel cross-cultural variation. School, sleep, play, and screen time were dominant activities in both research sites, although the total amount of time dedicated to these activities—and associations among them—varied in ways not captured by previous research. In Mexico City, children spent more time engaged with screen media (as found by Janssen et al., 2013; Singer et al., 2009), which, in turn, was positively associated with playtime. In Boston, screen time was negatively related to time in activities like playing, sleeping, and reading, mirroring one U.S. research study (Hofferth, 2009) but contrasting with another (Huston et al., 1999). Past scholars have argued that competing explanations for media influencing children's time use might be plausible depending on the nonmedia activities in question (Huston et al., 1999). As an extension, we consider the goodness of fit of differing time-use explanations across our two research sites, drawing from prior research on regional attitudes, practices, and constraints to help interpret results.

Although children in both sites spent a considerable amount of time engaging with screen media, media use was much higher among the Mexico City sample, consistent with previous research with older or wider age ranges (Janssen et al., 2013; Singer et al., 2009). This may be because Mexican parents are more optimistic about media's potential to educate (Silver et al., 2019) or may be a function of familial pressure for children to spend more time at home (Halgunseth et al., 2006; Singer et al., 2009), where digital devices are readily available. A number of structural constraints also may have kept our Mexico City sample inside and near screen media devices. Air pollution is high in Mexico City (Blake & Rowland, 1995), which might prompt parents to limit children's outdoor play. According to the U.S. Overseas Security Advisory Council (2017), the crime rate in Mexico City is higher than the U.S. national average. Prior research has found that parents who live in unsafe communities see indoor media use as a safe alternative to outdoor play (Janssen et al., 2013; Singer et al., 2009). In contrast to these findings in Mexico City, Boston participants spent more time playing outside.

The starkest contrast we observed was the different associations between media and other in-home activities like indoor play across the two samples—a finding not observed in prior research. In Mexico, where there is comparatively less negative public messaging around childhood screen time (Janssen et al., 2013), the more time children spent using media, the more time they spent playing and eating, as reflected in both our main and robustness models. The more, the more hypothesis seems to best explain these results (Mutz et al., 1993). When Mexican children have more unstructured time at home, they may eat, play, and consume more media. These data do not suggest that children in Mexico City are engaging in tradeoffs between screen time and time spent playing (or eating). In addition, the narratives to which media use exposes children may stimulate forms of indoor play, such as pretending to be characters from favorite television episodes (Valkenburg & Calvert, 2012). It also is possible that Mexican parents were more prone to consider children's screen-based engagement as a type of play.

Among children in Boston, findings for time spent at home were more consistent with the displacement hypothesis (Mutz et al., 1993); when children's media use was higher, there was some

evidence that they spent less time playing (both main and robustness model findings), reading (main model only), and sleeping (robustness model only). Parents' penchant for using of media in reward or punishment systems in the U.S. (Wartella et al., 2014) may make screen media seem more enticing to children than other activities, consequently leading screen media to displace certain activities in Boston but not in Mexico City. In Boston, it is possible that children chose or parents encouraged them to entertain themselves through traditional forms of play or reading during moments when they were discouraged from engaging with media. The potential tradeoff or negative association between these entertainments aligns with the functional similarity hypothesis (Huston et al., 1999). Other research suggests that U.S. parents may intermittently allow children to engage with screens as part of their bedtime rituals (Rideout, 2017), resulting in children occasionally indulging in bedtime habits where they play, read, and sleep less.

In both research sites, screen time was negatively related to time spent playing outside (both main and robustness models) or at school (main model only). Consistent with prior time-use studies, these findings may be best explained by the displacement hypothesis (Mutz et al., 1993). In our study and others (e.g., Rideout, 2017), young children's screen time is still dominated by the passive consumption of content on a television set—despite the increasing penetration of mobile media. Television sets are housed inside in both the U.S. and Mexico, such that children can either play outside or watch their television sets indoors. Limiting or encouraging children to limit their screen time has not been shown to increase physical activity (Robinson, 1999). Possibly, third structural variables such as access to outdoor space and parental work schedules impact both the use of screen media and outdoor activities in opposite directions. Because the negative relation between time in school and media use was noted only in the GEE models, it is possible that between—rather than within—subjects differences explain these results. Children with greater school commitments might have less time to consume media—a finding more consistent with the media-as-default hypothesis (Huston et al., 1999).

Strengths and Limitations

The analytical approach employed in this study is one of its primary strengths. The main models allowed for the use of all data parents provided, while still fundamentally replicating the approach used in other studies (e.g., Murray & Kippax, 1978). The robustness models facilitated the examination of within-subjects change, providing a more hypothesis-aligned test of displacement (Mutz, 1993). Together, both approaches supported a similar understanding of the pattern of results. Nevertheless, we urge readers to use caution when interpreting findings that were significant across only one of the many models we ran; evidence is most convincing in cases where findings were replicated across weekdays and weekends and across the main and robustness models.

Collecting data in two locations is another major strength of the study. Our data collection in two countries divulged complexities that may not have been obvious otherwise.

The primary limitation of this study is the relatively small sample size, attributable in large part to incomplete time-use diaries. Lack of data from some participants may limit the generalizability of findings. To retain as much of the sample as possible, we edited the diaries in a manner that aligned with prior literature but that was ultimately subjective. By implication, our time estimates might be less precise than what we would have calculated with a more complete data set. Our small sample also prevented us from being able to test for differences in patterns as a function of child age, sex, or SES. Future studies should

implement error messages when incomplete diaries are submitted per recent recommendations in related work (Chatzitheochari et al., 2018).

Conclusion

Our findings elucidate a relation between media use and time spent in other activities across settings (inside vs. outside the home) and cultures. A policy environment that discourages childhood screen media use, such as that of our Boston sample, may cause or reflect a majority culture in which children engage in lower amounts of media consumption. During the more limited windows that children in Boston are permitted to consume media, they may prioritize using their screens over other activities because they may be uncertain about when their next opportunity to engage with screens might be. Parents like those in our Boston sample might point their children toward screen-free alternatives. In places like Mexico, in which public health authorities have not issued guidelines around screen time (Janssen et al., 2013), media consumption may be higher and positively associated with engagement in other activities. If families are less concerned about the volume of media children consume, children may gladly engage in numerous activities on days when they have more leisure time. This study confirms that there are complex tradeoffs in children's time use and underscores the importance of considering the role of regional and cultural differences when attempting to study the lived and mediated experiences of today's children.

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