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Links between television exposure and toddler dysregulation: Does culture matter?

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ABSTRACT

Television exposure in early childhood has increased, with concerns raised regarding adverse effects on social-emotional development, and emerging self-regulation in particular. The present study addressed television exposure (i.e., amount of time watching TV) and its associations with toddler behavioral/emotional dysregulation, examining potential differences across 14 cultures.

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The sample consisted of an average of 60 toddlers from each of the 14 countries from the Joint Effort Toddler Temperament Consortium (JETTC; Gartstein & Putnam, 2018). Analyses were conducted relying on the multi-level modeling framework (MLM), accounting for between- and within-culture variability, and examining the extent to which TV exposure contributions were universal vs. variable across sites. Effects of time watching TV were evaluated in relation to temperament reactivity and regulation, as well as measures of emotional reactivity, attention difficulties, and aggression. Results indicated that more time spent watching TV was associated with higher ratings on Negative Emotionality, emotional reactivity, aggression, and attention problems, as well as lower levels of soothability. However, links between TV exposure and both attention problems and soothability varied significantly between cultures. Taken together, results demonstrate that increased time spent watching television was generally associated with dysregulation, although effects were not consistently uniform, but rather varied as a function of culturally-dependent contextual factors.

1. Introduction

Growing up in the digital age means early media exposure, with television viewing largely ubiquitous in the United States (U.S.) and other countries. An entire market has emerged that specifically targets young children with television shows, video games, and entire television networks aimed at infants as young as 1–18 months (Vandewater et al., 2007). Nearly all children (99 %) in the U.S. have a television in the home and consume such media at nearly the same rate as playing outside (Wartella et al., 2003). This phenomenon is not exclusive to the U.S. In fact, television watching has grown to become the most common childhood activity, surpassing outside play, across many countries including the U.S., Argentina, Brazil, the United Kingdom, France, Ireland, Portugal, India, Thailand, China, Pakistan, Indonesia, Vietnam, South Africa, Morocco, and Turkey (Singer et al., 2009).

The American Academy of Pediatrics (AAP) recommends that digital media be avoided for children under 18 months, with the exception of video chatting. Additionally, for parents who wish to introduce digital media between 18 and 24 months of age, the AAP advises parents to choose "high quality programming" (American Academy of Pediatrics, 2016). This recommendation aligns with much of the current research suggesting that media exposure can have negative effects on the youth consuming it. Media exposure at young ages (e.g., less than 3 years) can impact attention spans (Christakis et al., 2004; Zimmerman & Christakis, 2007), language development (Christakis et al., 2009; Tomopoulos et al., 2010) and self-regulation (Radesky et al., 2014). In addition, infant activity, fussiness, and crying are correlated with more television exposure (Thompson et al., 2013). These findings suggest that deficits in behavioral/emotional regulation and media exposure are interrelated. As media exposure becomes more prominent at younger ages, it is more imperative to understand how television in particular, the most ubiquitous of the media platforms, impacts developing self-regulation, and whether or not the cultural context plays a role.

Self-regulation has been described as an intrinsic process that integrates both a top-down (deliberate) and bottom-up (automatic) processing to influence or alter emotions, cognition, and behavior (Nigg, 2017). Self-regulation is used to modulate reactivity through executive attention and effortful control (EC), with the former defined as the ability to orient in a goal directed manner and the latter as the ability to engage in top-down processes to self-regulate (Nigg, 2017; Rothbart et al., 2011). Executive attention is required for effective EC, as top-down control of behavior (e.g., ability to inhibit a prepotent response in favor of a more adaptive novel response; Kochanska & Knaack, 2003) cannot be deployed without flexible, voluntary attentional responses.

Executive functions (EF) more broadly are also closely related to self-regulation. EF represent higher-order cognitive processes engaged to monitor and control attention, thoughts, and behaviors (Zhou et al., 2012), typically operationalized through measures of cognitive flexibility (i.e., set shifting), inhibitory control, and working memory (Miyake et al., 2000). There is admittedly considerable overlap between EF and EC: both include inhibitory control (Kochanska & Knaack, 2003), support self-regulation (Diamond, 2013; Eisenberg, 2017; Nigg, 2017; Zhou et al., 2012), and have been linked with prefrontal cortex maturation and activity (Fiske & Holmboe, 2019; Posner et al., 2012). Historically, EF research has focused on "cool" situations – contexts that inhibit or minimize emotion – with EC studies examining "hot" situations that elicit emotion (Diamond, 2013); however, even this distinction is not universal (Zelazo & Carlson, 2012). It would be most accurate to say that EC has gained prominence as the key aspect of self-regulation based on the temperament framework, whereas EF has its roots in cognitively oriented research, and as such they represent two ends of a self-regulation continuum (Zelazo & Cunningham, 2007; Zhou et al., 2012). Understanding factors contributing to the advancement of EF, EC, and self-regulation, as well as their deficits, or dysregulation, will thus increase our knowledge of social-emotional and cognitive development.

The present study is rooted in Rothbart's psychobiological model of temperament, according to which individual differences incorporate self-regulation along with reactivity, and both are informed by one's biological makeup and impacted by maturation and environment (Rothbart & Derryberry, 1981). Temperamental reactivity and regulation encompass motivation, emotions, behavioral dispositions, and attention capabilities of the individual, which are viewed as providing the basis for self-regulation across the lifespan. Thus, Rothbart's psychobiological model conceptualizes temperament in terms of how a person reacts to stimuli (internal and external) and in turn, is able to modulate this reactivity, and dysregulation encompasses both excessive (i.e., under-regulated) reactivity and low levels of attention-based regulatory capacity (Gartstein et al., 2016). As noted, EC has been established as the regulation-related domain in temperament research, understood as the ability to modulate emotions and behaviors by utilizing inhibition and attention. It is typically defined to include inhibitory control, attention shifting, low-intensity pleasure, cuddliness, and

attention focusing, based on factor analytic studies (e.g., Rothbart et al., 2001).

Reactivity domains, subject to modulation by EC, include Negative Emotionality and Surgency. Negative Emotionality encompasses the tendency for an individual to react with negative emotions and has been associated with aggression (Garofalo et al., 2018), as well as other behavioral/emotional problems (Gartstein et al., 2012). Structurally, Negative Emotionality consists of discomfort, fear, sadness, frustration, motor activation, perceptual sensitivity, shyness, and soothability, which loads negatively onto this factor. Soothability facilitates emotion regulation, referring to the rate of recovery after distress. Surgency, which is made up of impulsivity, activity level, high-intensity pleasure, sociability, and positive anticipation, is commonly thought of as a tendency toward positive affect; however, high levels are indicative of under-control, linked to externalizing problems (Degnan et al., 2011). Thus, multiple attentional as well as behavioral/emotional tendencies must be considered to gain insight into underlying dysregulation (Babineau et al., 2015).

Development of reactivity and regulation is a function of contextual factors, culture critical among these (Rothbart, 2012). It has long been thought that children are socialized to manifest behavioral phenotypes consistent with culturally-driven values, attitudes, and expectations (Kohnstamm et al., 1989), with a large number of reported cross-cultural temperament differences providing support for this view. A number of differences in inhibitory control, soothability, cuddliness, attention focusing and shifting, as well as low intensity pleasure (ability to enjoy quiet/calm activities, low in stimulus value), have been noted along with those involving Surgency and Negative Emotionality (Cozzi et al., 2013; Desmarais et al., 2019; Gartstein et al., 2003, 2006; Krassner et al., 2017; Montirosso et al., 2011; Slobodskaya et al., 2013; Sung et al., 2015). Similarly, attention problems have been associated with some of the strongest and consistent effects in cross-cultural investigations (e.g., Achenbach & Rescorla, 2007), albeit typically with older children. A meta-analysis conducted by Polanczyk et al. (2007) suggested very high rates of attention problems in South America, moderate rates in North America and Europe, and low levels in Asia. Overall, previously reported cross-cultural differences indicate variability in regulation development, as well as emotional/behavioral dysregulation; thus, it is important to investigate potential contributors to dysregulation emerging from the cultural context, including television exposure in early childhood.

Early childhood is a foundational period for the development of self-regulation (Diamond, 2013), and television exposure has been hypothesized to disrupt related processes (Cliff et al., 2018). Radesky et al. (2014) found that children who were rated as more "difficult", or dysregulated, in terms of their temperament (i.e., higher in negative reactivity and lower in regulation) by their parents spent more time watching television. Additionally, higher overall use of television in the home negatively impacted children's executive functioning, closely linked with self-regulation as noted above (Barr et al., 2010). Cliff et al. (2018) found that greater media exposure at 2 years of age contributed to lower self-regulation when children were 4 years old. Early television exposure has been linked to language delays (Byeon & Hong, 2015), hyperactivity-inattention and social problems (Cheng et al., 2010), lower inhibition (McHarg et al., 2020), and overall deficits in development of EF (Jusienė et al., 2020; Nathanson et al., 2014). Collectively, early and lengthy television exposure appears to adversely impact self-regulation.

However, this negative impact is not ubiquitous, especially in the context of international investigations. For example, Yang et al. (2017) found that children in China watched less television and also did not experience the same negative impacts on EF as had been reported in other studies. Educational programming has been evaluated around the world (Mares & Pan, 2013), including Rwanda (Borzekowski et al., 2019), Israel, the West Bank, Gaza (Cole et al., 2003), and Indonesia (Borzekowski & Henry, 2011). These programs have been linked to increased early learning skills (Borzekowski & Henry, 2011), social skills (Cole et al., 2003), and general knowledge (Mares & Pan, 2013). Importantly, television exposure in early childhood is a world-wide phenomenon, as for example in Turkey half of children sampled watched 2 h of television, often alone without the guidance of a parent (Yalcin et al., 2002). Similar findings have been reported in Spain (Mielgo-Ayuso et al., 2017) and Canada (McMillan et al., 2015). Variability in television exposure across cultures has also been demonstrated (e.g., 2–3.7 hours for Sweden and Ukraine, respectively; Vereecken et al., 2006). Given noted cross-cultural differences in regulation development, it is critical to understand how variability in television exposure across cultures contributes behavioral/emotional difficulties and impairment (Althoff et al., 2010).

The present study has two aims that attempt to advance understanding of relationships between culture, television exposure, and dysregulation. The first aim was to assess the role of time spent watching television (TV) in explaining within-culture differences in (dys)regulation-related outcomes (i.e. *within-level*). It was hypothesized that toddlers' ability to regulate behavior/emotions (or lack thereof) would be associated with the amount of time spent watching TV across different cultures included in this research, after accounting for covariates. That is, greater TV exposure was expected to be associated with lower levels of regulation-related attributes (and higher levels of behavioral/emotional manifestations of dysregulation) regardless of cultural backgrounds, controlling for age and gender. Our second aim was to examine the role of time spent watching TV with respect to cross-cultural differences in (dys) regulation (i.e., *between-level*). Specifically, the present study was designed to explore the possibility that the association between time spent watching TV and different aspects of regulation may vary by country - this relationship may be more pronounced in some cultures and weaker in others. The latter aim should be considered exploratory, as specific a-priori expectations were not formulated due to the dearth of existing research. We explore these questions using a multilevel modeling (MLM) approach to highlight the analytic framework for cross-cultural investigations.

2. Methods

2.1. Participants

The sample consisted of participants from 14 countries ($N = 841$, *n*s range 49–97) from the Joint Effort Toddler Temperament Consortium (JETTC; Gartstein & Putnam, 2018). These data, which were collected between 2015 and 2017, represent participants

Table 1
Sample demographics by culture.

	Child Gender[1]		Child Age (in months)			Family Socio-Economic Status (RDSI)[2]			Marital Status (in percent)[3]				Maternal Education (in years)			Maternal Age (in years)			# of Children in the Household		
Culture	F	M	Range	*M*	*SD*	Range	*M*	*SD*	Ma	Lt	Di	Si	Range	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*
Belgium	21	27	17–41	25.7	5.3	10–97	63.8	21.1	56	38	12	4	10–32	18.0	2.9	27–38	32.26	2.67	1–5	1.9	1
Brazil	23	28	18–38	29.4	5.6	15–96	56.9	24.2	82	12	0	6	11–37	18.3	4.9	22–43	32.90	4.55	1–3	1.4	1
Chile	21	28	17–41	27.3	7.2	10–97	49.7	28.3	62	15	2	21	12–28	18.1	4.9	17–41	28.54	7.11	1–4	1.8	1
China	30	24	19–36	26.4	4.7	15–97	58.7	29.9	87	13	0	0	8–23	15.6	3.6	21–40	30.11	3.99	1–2	1.2	1
Finland	24	31	18–40	27.6	5.7	10–97	61.6	20.8	62	30	2	6	12–26	17.7	2.6	24–41	33.57	3.87	1–4	1.5	1
Italy	24	28	17–36	26.6	4.9	15–97	61.9	20.6	77	23	0	0	11–25	17.2	3.1	30–48	37.15	3.72	1–5	1.7	1
Mexico	25	29	18–36	26.4	5.6	10–97	38.3	29.8	69	24	6	1	9–25	16.8	3.8	17–43	32.35	5.89	1–5	1.6	1
Netherlands	55	64	16–40	26.6	5.8	10–87	56.6	22.3	53	40	2	5	5–25	17.7	3.7	20–41	31.99	4.27	1–3	1.6	1
Romania	30	28	17–38	21.2	6.4	15–97	72.4	19.4	98	2	0	0	12–29	18.1	6.4	23–41	32.91	3.93	1–3	1.4	1
Russia	26	25	17–36	27.0	5.6	15–93	62.8	19.0	77	21	2	0	10–22	14.9	2.1	21–43	29.37	5.20	1–8	1.6	1
Spain	27	35	18–35	26.1	5.1	10–97	58.2	27.3	74	18	1	7	8–21	15.6	4.2	29–43	35.88	3.55	1–4	1.8	1
S. Korea	26	27	17–35	28.0	4.8	15–96	51.6	24.5	100	0	0	0	7–18	15.3	2.2	29–44	34.58	3.45	1–3	1.9	1
Turkey	25	34	16–36	27.7	5.6	10–97	50.5	26.1	92	7	1	0	9–24	14.4	3.9	19–46	31.78	5.46	1–4	1.4	1
US	49	39	17–36	25.6	5.8	10–97	50.3	26.2	92	7	1	0	9–24	17.2	2.3	23–46	33.1	4.47	1–6	1.7	1

Notes: [1]F = Female, M = Male.
[2]RDSI: Revised Duncan Sociometric Index – An occupation based measure of social prestige, based on maternal occupations (Stevens & Featherman, 1981).
[3]Ma = Married, Lt = Living Together, Di = Divorced, Si = Single.
Table adapted with permission from (Putnam et al., 2018).

Table 2
Cronbach's Alphas for ECBQ temperament scores and CBCL scales.

Factor/Scale	Brazil	South Korea	Spain	Mexico	Russia	Italy	Belgium	Finland	Netherlands	Romania	China	United States	Turkey	Chile
ECBQ Surgency	.80	.85	.88	.87	.88	.85	.84	.81	.87	.87	.87	.85	.86	.84
ECBQ Negative Emotionality	.93	.89	.89	.90	.88	.91	.90	.87	.89	.89	.85	.90	.92	.89
ECBQ Effortful Control	.85	.92	.91	.82	.87	.88	.93	.91	.88	.87	.87	.92	.87	.89
ECBQ Attention Focusing	.69	.79	.81	.74	.81	.85	.90	.88	.80	.77	.83	.85	.75	.74
ECBQ Attention Shifting	.63	.72	.62	.55	.56	.56	.68	.67	.71	.71	.39	.69	.60	.67
ECBQ Cuddliness	.81	.86	.91	.79	.82	.79	.90	.86	.82	.84	.83	.87	.80	.81
ECBQ Inhibitory Control	.90	.89	.89	.65	.82	.85	.80	.86	.86	.82	.85	.88	.78	.87
ECBQ Low Intensity Pleasure	.56	.73	.72	.67	.68	.76	.78	.60	.74	.62	.65	.72	.73	.80
ECBQ Soothability	.76	.81	.78	.74	.84	.78	.84	.87	.83	.77	.68	.78	.75	.60
CBCL Attention Problems	.59	.60	.64	.53	.68	.73	.72	.62	.70	.50	.57	.67	.51	.68
CBCL Emotional Reactivity	.74	.73	.67	.63	.63	.69	.70	.62	.73	.52	.83	.64	.78	.65
CBCL Aggression	.90	.89	.85	.84	.86	.87	.86	.79	.91	.90	.89	.87	.85	.94

from the United States, Brazil, Spain, Mexico, Italy, Russia, Finland, Romania, Belgium, the Netherlands, China, South Korea, Turkey, and Chile. Researchers at all of the sites recruited samples of toddlers who were between 15.87 and 40.97 months of age ($M = 26.88$ months, $SD = 5.65$ months) from about 60 families (*n*s range 49–97). Gender was approximately equally divided among boys and girls (boys $n = 440$; girls $n = 401$). Only one child was selected from each family. Additionally, children with clinical diagnoses were excluded. Although links between TV viewing and regulation in clinical populations are important to consider, related research questions were beyond the scope of the current investigation. For all but two countries, data were collected in a single site. In the Netherlands and the U.S., data from two locations were combined. Although recruitment approaches necessarily differed by site, as is common with cross-cultural research (Keller, 2007) because identical techniques are not viable in all locations, our samples can be thought of as similarly representative of communities from which they were recruited. The samples are also reflective of the circumstances predominant in each country/community, such as marital status and maternal education, despite some variability in demographic characteristics. Participating families represent a range of occupations, primarily reflecting mid socio-economic status (Revised Duncan Sociometric Index, RDSI (Stevens & Featherman, 1981) $M = 55.64$, $SD = 25.82$). Table 1 provides demographic statistics for each culture.

2.2. Measures

The Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006) is a parent-report instrument used to assess temperament in children between 18–36 months of age. Although the ECBQ is designed for optimal use with children 18- to 36-months of age, a small subset of children between 15- and 18-months ($n = 22$, ~2.6 % of overall sample) and 37- and 40-months of age ($n = 13$, ~1.5 % of overall sample) were included in the study. Mild expansion of age ranges is typical for childhood temperament instruments as items remain developmentally appropriate (Putnam et al., 2014). The ECBQ consists of 201 items, rated on a 7-point rating scale, and distributed over 18 scales and three factors: Negative Emotionality (discomfort, fear, sadness, frustration, motor activation, perceptual sensitivity, shyness, and soothability, loading negatively), Surgency (impulsivity, activity level, high-intensity pleasure, sociability, and positive anticipation), and Effortful Control (EC; inhibitory control, attention shifting, low-intensity pleasure, cuddliness, and attention focusing). Because of our focus on dysregulation, this study examined the three broad factors (including Negative Emotionality and Surgency, reflective of reactivity), all EC subscales, and soothability, negatively loading on Negative Emotionality. Prior studies support longitudinal stability and inter-parent agreement for ECBQ indicators (Putnam et al., 2006), as well as predictive validity relative to childhood temperament measures (Putnam et al., 2008), construct validity via connections to behavior problems (Gartstein et al., 2012), and convergence with laboratory assessment tools (Stepien-Nycz et al., 2017).

With respect to measurement refinement to produce a culturally consistent measure, for 13 scales, no items were deleted due to internal consistency considerations. Two items each from attention focusing and impulsivity, and one each from attention shifting and low-intensity pleasure were removed to optimize Cronbach's Alphas (Table 2). Internal consistency for impulsivity, remained below .60 in eight countries; therefore, this scale was not used in analyses. However, a total of 8 optimally-performing items were retained in creation of the Surgency factor score to enhance comparability of our findings to those obtained in other studies. "However, a total of 8 optimally-performing items from the impulsivity scale were retained in creation of the Surgency factor score to enhance comparability of our findings to those obtained in other studies."

The Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000) is used to assess behavior problems in children ages 18 months to 5 years. The CBCL contains 100 items, rated on a 3-point rating scale, used to assess a variety of behavior problems. Only attention problems, emotional reactivity, and aggression scales were utilized in this study as markers of dysregulation, because of links between attention and regulatory capacity (Gartstein et al., 2013; Posner et al., 2012; Rothbart & Bates, 2006), as well as regulation deficits, emotional under-control and aggression (Garofalo et al., 2018; Gartstein et al., 2012). Reliability and validity of the scores are well established, with adequate criterion-related validity, inter-rater and test-retest reliability (Achenbach & Rescorla, 2000). The CBCL has been used extensively in prior cross-cultural research (Achenbach & Rescorla, 2007). Although several alphas were $< .60$, scale refinement was not undertaken due to the widespread use of the CBCL and its scales in cross-cultural investigations (e.g., Achenbach & Rescorla, 2007; Achenbach et al., 2008), and to maintain comparability with existing studies. The sample size was somewhat smaller for the CBCL analyses ($N = 836$), as 5 caregivers failed to complete this measure.

The Daily Activities Questionnaire (DAQ; Gartstein & Putnam, 2018) is a parent-report instrument designed to assess leisure activities, sleeping practices, and discipline routines. It included 46 items regarding how often parents or children engage in related behaviors. Although this questionnaire assesses many aspects of the daily activities, in this study we focused on responses to a question accessing time children spent watching TV measured in hours per day. Specifically, the parents were asked: "How much time does your child spend watching television (hours per day)?"

2.3. Statistical analysis

Multilevel linear regression models were estimated using STATA® version 14.

Although a comprehensive discussion of MLM is outside the scope of the present paper (see Hox et al., 2018 for a more comprehensive treatment of MLM), the advantages of this approach in cross-cultural research will be briefly outlined. First, this framework accounts for the "nested" structure of cross-cultural data. That is, in contrast to traditional group comparisons wherein subjects are treated as randomly and independently sampled or assigned to groups in a manner such that the net effect of their personal "error" (e.g., idiosyncratic differences) is minimized in relation to the effect of variables of interest, in cross-cultural research individuals within a culture are not randomly assigned and are inherently similar to one another. Thus, differences observed between groups are likely to be

at least partially explained by contextual similarities between individuals within a culture. In other words, the clustering or grouping of individuals within a sample directly influences sample variance (Hox et al., 2018). In order to account for this influence, MLM produces appropriate standard errors, compared to traditional methods (e.g., OLS regression), which is critical because failure to do so can increase the risk of Type I error (e.g., Misangyi et al., 2006).

An additional advantage of using MLM for cross-cultural research is that variance between and within cultures is partitioned and parameters are estimated separately for these components. That is, rather than within-group variance being synonymous with error variance, as in an ANOVA framework, MLM allows researchers to control for and explain both intra- and inter-group differences. In contrast to OLS regression, which estimates a single equation to model a relationship between variables, MLM estimates an equation that reflects how a relationship varies between groups by incorporating fixed and random intercepts. Whereas the fixed portion of a model essentially represents the "universal" effect of variables, the random components of a model, expressed in terms of variance, estimate the degree to which variable relationships differ between groups. In essence, this is similar to simultaneously estimating a different OLS regression line for each country in this study. Thus, random slope estimation allows the relationship between dependent and independent variables to differ across groups, and in the present study, random slopes will reflect the variance in the strength of the association between time spent watching TV and parental ratings of child (dys)regulation.

Models were constructed in four phases for each of the 12 self-regulation variables (i.e., three broad temperament factors, six fine-grained temperament dimensions, and three CBCL scales) included in this study. Child age and gender were included as covariates in all models to enhance generalizability of findings to previous cross-cultural developmental studies. Time spent watching television was grand-mean centered, meaning that the mean of all participants was subtracted from individual participant's scores (Enders & Tofighi, 2007). As such, model coefficients for covariates will represent the effects of age and gender when time spent watching television is fixed at the mean.

First, a null model was estimated. The null model partitions both within- and between-level variance and provides a standard to which subsequent models are compared. The general null model can be noted as

$$\text{Regulation}_{ij} = \gamma_{00} + u_{0j} + r_{ij} \tag{1}$$

where Regulation_{ij} is the estimated temperament rating for individual *i* in group *j* (generically, this portion of a null model is noted as Y_{ij}), Y_{00} is the sample grand-mean, u_{0j} is the variation of group *j* from the grand mean, and r_{ij} is the error term associated with individual *i* in group *j*. In this model, serves as the "fixed" portion of the model, meaning it is consistently represented for each individual regardless of their culture. In contrast, both u_{0j} and r_{ij} reflect random components of the model. Specifically, the term u_{0j} allows for intercepts to vary across groups (i.e., allows for each culture have a unique intercept), whereas r_{ij} allows for estimation of the level-1 (i.e., individual-level) error term. Additionally, the intraclass correlation (ICC), or percentage of variance in the outcome accounted for by differences between cultures (i.e., the ration of between-culture variance to total variance), can be calculated for any model and is presented for each null model. Next, age and gender covariates were entered

$$\text{Regulation}_{ij} = Y_{00} + Y_{10}(\text{Age}_{ij}) + Y_{20}(\text{Gender}_{ij}) + u_{0j} + r_{ij} \tag{2}$$

where Y_{10} and Y_{20} reflect the regression coefficients associated with the fixed effects of age and gender. Next, a third model incorporating the hours spent watching TV was estimated as

$$\text{Regulation}_{ij} = Y_{00} + Y_{10}(\text{Age}_{ij}) + Y_{20}(\text{Gender}_{ij}) + Y_{30}(\text{TV}_{ij}) + u_{0j} + r_{ij} \tag{3}$$

where Y_{30} denotes regression coefficients associated with time spent watching TV. The results of this model addressed the first aim of the study, which is to understand the association between time spent watching TV and temperamental aspects of regulation for individuals within and between cultures (i.e., fixed effects).

Finally, a fourth model was estimated to allow for slopes to vary between cultures:

$$\text{Regulation}_{ij} = Y_{00} + Y_{10}(\text{Age}_{ij}) + Y_{20}(\text{Gender}_{ij}) + Y_{30}(\text{TV}_{ij}) + u_{01}(\text{TV}_{ij}) + u_{0j} + r_{ij} \tag{4}$$

where variables are as previous defined with u_{01} reflecting the between-culture variance in the relationship between time spent watching TV and different aspects of regulation. The results of this model addressed our second aim. That is, the relationship between time spent watching TV and a particular aspect of dysregulation was considered to vary between cultures if the inclusion of a random slope significantly improved model fit. Importantly, this model was only estimated for instances in which the previous model (i.e., one in which time spent watching TV was significantly associated with regulation) accounted for significant variance. Thus, random slopes were not included for aspects of regulation that were not significantly related to time spent watching television. It should be noted that MLM allows for the specification of a correlation between intercepts and slopes (Hox et al., 2018); however, these were not significant for any model in the present study.

Restricted maximum likelihood estimation (REML) was used to obtain the parameter estimates and maximum likelihood estimation was used to obtain the deviance estimates for model comparison purposes (Hox et al., 2018; Snijders & Bosker, 2012). Models were evaluated and compared using a variety of fit indices including Akaike's Information Criterion (AIC; Akaike, 1987), Bayesian Information Criterion (BIC; Schwarz, 1978), and chi-square difference tests, with superior model fit indicated by relatively lower AIC and BIC values. That is, these values have no intrinsic meaning, but models with the lower values are preferred. Additionally, a significant χ^2 difference test signals a significant improvement in model fit for comparing nested models. In order to assess practical significance, changes in both within- and between-culture variance will be calculated using the formula described by Hox et al. (2018)

R^2 = (Model 1 Estimate - Comparison Model Estimate) / (Model 1 Estimate) (5)

Importantly, models were only deemed acceptable if overall improvement in fit was observed. That is, demonstrating a statistically significant relationship between TV exposure and indices of regulation alone will not be deemed sufficient evidence of meaningful/reliable effects.

3. Results

Descriptive statistics for all of the variables examined in this study were computed first (Table 3). Tables 4–8 provide model estimation parameters and fit indices for models predicting ratings of Negative Emotionality, emotionality reactivity, aggression, soothability, and attention problems. For each of these variables, time spent watching TV was statistically significant in predicting regulation-related ratings while controlling for age and gender. For Negative Emotionality, the null model ICC was estimated at .207, indicating that 20.7 % of the total variance in Negative Emotionality occurs at the culture-level. With regard to time spent watching television (i.e., Table 4/Model 2), a one standard deviation increase in time spent watching television was associated with a .13 standard deviation increase in parent ratings of Negative Emotionality. For emotional reactivity (Table 5), the null model indicated that 5.64 % of the total variance occurred at the culture-level, and a one standard deviation increase in time spent watching television predicted a .16 standard deviation increase in emotional reactivity. For aggression, 8.63 % of the variance occurred at the culture-level, and a standard deviation increase in TV exposure was associated with a .11 standard deviation increase in aggression.

Time spent watching TV was also significantly associated with both soothability (i.e., Table 7/Model 2) and attention problems (i.e., Table 8/Model 2); however, these relationships varied significantly between cultures as evidenced by improved model fit after the inclusion of random slopes (i.e., Model 3). The null model ICC for soothability revealed that 12.3 % of the total variance occurred at the cultural level. A one standard deviation increase in time spent watching TV predicted a .29 standard deviation decrease in parental ratings of soothability. However, the significant variance in slopes indicates that this relationship differed significantly between cultures. These differences are illustrated in Fig. 1, which demonstrates the model-implied relationship between time spent watching TV and parental ratings of soothability for each culture. This model accounted for 22.22 % of the between-culture and 4.76 % of the within-culture variance remaining after accounting for age and gender covariates. For attention problems, the null model indicated that 4.4 % of the total variance could be explained at the culture-level, and model 2 estimates indicated a one standard deviation increase in time spent watching TV predicted a .27 standard deviation increase in ratings of attention problems. Again, the significant variance around the slope suggests that the relationship between time spent watching TV and ratings of attention problems differs between cultures. This relationship is illustrated in Fig. 2. This final model accounted for 7.14 % more between-culture and 3.73 % more of the within-culture variance remaining after the inclusion of age and gender covariates.

In addition to considering the increase in variance accounted for, plausible value ranges (Raudenbush & Byrk, 2002) can be useful in understanding the magnitude of cross-cultural differences in the relationships between TV exposure and both soothability and attention problems. The value ranges are calculated by multiplying the fixed-effect estimate for time spent watching television by the upper and lower bound of a 95 % confidence interval of the random slope parameter. For soothability, the lower-bound estimate was $-.21$ ($-.1-1.96\sqrt{.003}$), whereas the upper-bound was .01 ($-.1 + 1.96\sqrt{.003}$). Thus, the effect of soothability in cultures with the greatest effect is 21 times stronger that in cultures with the smallest effect. Similarly for attention problems, the lower-bound estimate was .00 ($.2-1.96\sqrt{.01}$) and the upper-bound was .40($.2 + 1.96\sqrt{.01}$). As such, the effect is 100 times stronger in cultures with the greatest effect in comparison to cultures with the weakest effect. In essence, these estimates provide the means of gauging effect sizes of the random slopes, indicating that associations between TV exposure and both soothability and attention problems vary considerably between cultures.

Table 3
Descriptive Statistics.

Factor/Scale	*M*	*SD*	Skew	Kurtosis	Range
ECBQ					
Surgency	4.89	.54	-.09	3.33	2.52 – 6.48
Negative Emotionality	2.98	.53	.35	3.19	1.60 – 4.85
Effortful Control	4.68	.85	-.28	2.95	3.07 – 6.54
Attention Focusing	4.49	.85	-.28	2.95	1.70 – 7.00
Attention Shifting	4.71	.64	.07	2.96	2.88 – 7.00
Cuddliness	5.31	.81	-.58	3.44	2.25 – 7.00
Inhibitory Control	3.90	.93	.09	2.84	1.00 – 6.75
Low-Intensity Pleasure	4.99	.76	-.49	3.31	2.40 – 6.80
Soothability	5.31	.84	-.70	3.57	1.33 – 6.89
CBCL					
Attention Problems	2.64	1.77	.49	2.98	.00 – 8.00
Emotional Reactivity	2.61	2.38	1.24	5.39	.00 – 17.00
Aggression	10.51	6.45	.53	2.93	.00 – 34.26
DAQ					
Time Spent Watching TV	1.68	2.42	4.00	26.14	.00 – 21.00

Note: Early Childhood Behavior Questionnaire (ECBQ) scales/factors are based on averages of relevant items; Child Behavior Checklist (CBCL) scales are a sum of component items; and the Daily Activities Questionnaire (DAQ) Time Spent Watching TV is in hours/day.

Table 4
Model estimates for ECBQ Negative Emotionality.

	Model 1		Model 2		Model 3	
	Est.	*SE*	Est.	*SE*	Est.	*SE*
Fixed Components						
Intercept	2.83	.11	2.86	.11	2.88	.10
Age	.01*	.00	.01*	.00	.01	.00
Gender	−.03	.03	−.04	.03	−.04	.03
Time spent watching TV (hours)			.03**	.01	.04**	.01
Variance Components						
Within	.23	.01	.23	.01	.23	.01
Between						
Intercept	.06	.02	.06	.02	.06	.02
Slope					.00	.00
Model Fit						
χ^{2a}	1189.55		1177.77		1176.64	
AIC	1217.94		1215.99		1215.96	
BIC	1241.61		1244.39		1249.10	
R^2 within (%)[b]			.00		.00	
R^2 between (%)[b]			.00		.00	

Notes: Est = Estimate. [a]χ^2 were estimated using full maximum likelihood. [b] R^2 represents in the variance explained in comparison to the previous model.
* $p < .05$.
** $p < .01$.

Table 5
Model estimates for CBCL Emotional Reactivity.

	Model 1		Model 2		Model 3	
	Est.	*SE*	Est.	*SE*	Est.	*SE*
Fixed Components						
Intercept	2.65	.49	2.80	.48	2.80	.48
Age	.00	.01	.00	.01	.00	.01
Gender	−.05	.16	−.03	.16	−.03	.16
Time spent watching TV (hours)			.16**	.04	.16**	.04
Variance Components						
Within	5.36	.26	5.25	.26	5.25	.26
Between						
Intercept	.32	.16	.33	.17	.33	.17
Slope					.00	.01
Model Fit						
χ^{2a}	3794.41		3776.44		3776.44	
AIC	3814.61		3803.39		3805.38	
BIC	3838.25		3831.76		3838.48	
R^2 within (%)[b]			2.10		.00	
R^2 between (%)[b]			−3.13		.00	

Notes: Est = Estimate. [a]χ^2 were estimated using full maximum likelihood. [b] R^2 represents in the variance explained in comparison to model 1.
**$p < .01$.

4. Discussion

Results of this present study indicate that more time spent watching TV was associated with increased ratings of Negative Emotionality, attention problems, emotional reactivity, and aggression, as well as decreased soothability. Importantly, for attention problems and soothability, the strength of this relationship varied significantly between cultures, as evidenced by improved model fit with the inclusion of random slope parameters. For example, time spent watching TV was less strongly associated with dysregulation for Spanish toddlers relative to a number of other cultures, whereas the links with TV exposure were stronger for children from the Netherlands, with respect to soothability and attention problems. The present investigation extends existing studies demonstrating cross-cultural differences in (dys)regulation and time spent in front of the television (Achenbach & Rescorla, 2007; Montirosso et al., 2011; Polanczyk et al., 2007; Slobodskaya et al., 2013; Sung et al., 2015; Vereecken et al., 2006). Future research should seek to replicate effects reported herein, estimating random slopes and also considering their underpinnings (e.g., potential protective factors relative to TV exposure in cultures such as Spain).

Our findings align with the existing literature examining television, reactivity and regulation in young children, specifically that early TV exposure is correlated with difficulties in attention and soothability. It has been suggested that television and other electronic devices serve as “electronic babysitters,” especially for infants and young children with “difficult” temperaments (Chassiakos et al.,

Table 6
Model estimates for CBCL Aggression.

	Model 1		Model 2		Model 3	
	Est.	*SE*	Est.	*SE*	Est.	*SE*
Fixed Components						
Intercept	9.63	1.33	9.87	1.33	9.96	1.33
Age	.00	.04	−.01	.04	−.02	.04
Gender	.74	.43	.78	.43	.78	.43
Time spent watching TV (hours)			.28**	.10	.40**	.15
Variance Components						
Within	38.28		38.00	1.88	37.85	1.88
Between						
Intercept	3.56		3.49	1.63	3.33	1.58
Slope					.06	.10
Model Fit						
χ^{2a}	5442.71		5435.43		5435.11	
AIC	5456.65		5454.12		5455.14	
BIC	5480.30		5482.49		5488.24	
R^2 within (%)[b]			.73		.39	
R^2 between (%)[b]			1.97		4.58	

Notes: Est = Estimate. [a]χ^2 were estimated using full maximum likelihood. [b] R^2 represents in the variance explained in comparison to the previous model.
**p < .01.

Table 7
Model estimates for ECBQ Soothability.

	Model 1		Model 2		Model 3	
	Est.	*SE*	Est.	*SE*	Est.	*SE*
Fixed Components						
Intercept	5.55	.16	5.50	.16	5.46	.15
Age	−.01*	.00	−.01*	.00	−.01	.00
Gender	.04	.05	.03	.05	.03	.05
Time spent watching TV (hours)			−.06**	.01	−.10**	.02
Variance Components						
Within	.63	.04	.61	.03	.60	.03
Between						
Intercept	.09	.04	.08	.04	.07	.03
Slope					.003	.002
Model Fit						
χ^{2a}	2023.63		2003.93		1996.74	
AIC	2049.58		2038.79		2032.51	
BIC	2073.54		2067.19		2065.65	
R^2 within (%)[b]			3.17		4.76	
R^2 between (%)[b]			11.11		22.22	

Notes: Est = Estimate. [a]χ^2 were estimated using full maximum likelihood. [b] R^2 represents in the variance explained in comparison to the previous model.
* p < .05.
** p < .01.

2016). However, the current study suggests that soothability is not enhanced with television viewing, and the association is in the opposite direction. Even background television negatively impacts children's play (Schmidt et al., 2008) and parent-child interactions (Anderson & Evans, 2001; Kirkorian et al., 2009) by decreasing attention for both children and parents, leading to a reduction in active engagement. Thus, any potential benefits of television stimulation as a novel source of entertainment and distraction for young children appear short lived, with likely adverse effects in the long-term. As noted, some benefits of educational programming have been reported across cultures (Borzekowski & Henry, 2011; Cole et al., 2003; Mares & Pan, 2013); however, these generally present later in childhood, after foundational self-regulation skills have "come online".

The current study also found a positive correlation between time spent watching TV and parent-rated attention problems - as time spent watching TV increased, so did attention problem scores. This finding is also consistent with previous research examining links between television and attention. Notably, Lillard and Peterson (2011) found that after 9 min of watching a fast-paced fantastical cartoon, children (age 4) demonstrated immediate negative effects in terms of their executive functioning (i.e. working memory and self-regulation). While Lillard and Peterson were careful to specify this effect is likely temporary, other studies have found more stable, prolonged consequences with respect to attention problems. Christakis et al. (2004) reported that early exposure to television increased the probability that the child would develop subsequent attentional problems by age 7, as measured by the CBCL. There is

Table 8
Model estimates for CBCL Attention Problems.

	Model 1		Model 2		Model 3	
	Est.	*SE*	Est.	*SE*	Est.	*SE*
Fixed Components						
Intercept	3.71	.31	3.83	.32	3.89	.31
Age	−.04**	.01	−.05**	.01	−.05**	.01
Gender	.13	.12	.15	.12	.15	.12
Time spent watching TV (hours)			.12**	.03	.20**	.05
Variance Components						
Within	2.95	.15	2.88	.14	2.84	.14
Between						
Intercept	.14	.08	.16	.09	.13	.01
Slope					.01	.01
Model Fit						
χ^{2a}	3291.94		3273.97		3267.81	
AIC	3314.10		3303.40		3298.24	
BIC	3337.75		3331.77		3331.33	
R^2 within (%)[b]			2.37		3.73	
R^2 between (%)[b]			−14.29		7.14	

Notes: Est = Estimate. [a]χ^2 were estimated using full maximum likelihood. [b] R^2 represents in the variance explained in comparison to the previous model.
**p < .01.

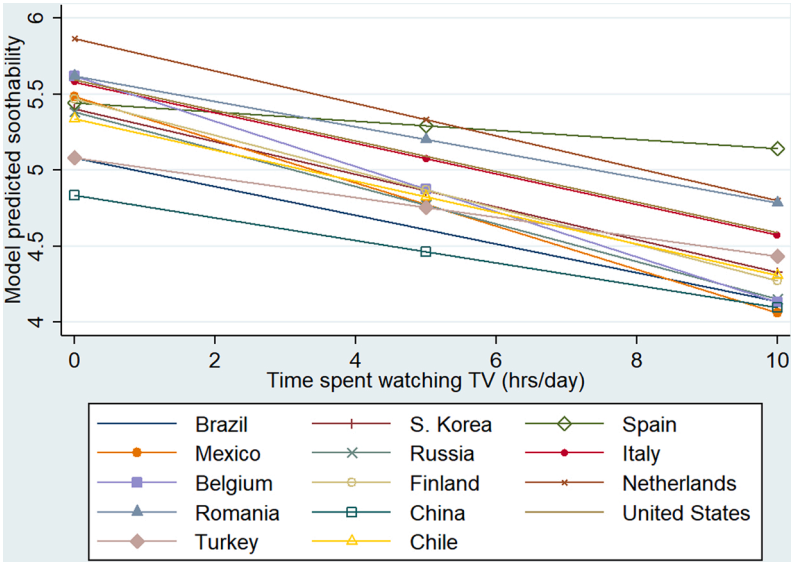

Fig. 1. Model-implied ratings of soothability predicted by time spent watching TV.

evidence for a critical level of television watching (2 h/day) associated with increased risk of externalizing difficulties marked by behavioral/emotional dysregulation, specifically attention problems (Tamana et al., 2019). In fact, television exposure was associated with the greatest risk for attention difficulties, surpassing sleep, socioeconomic status, and parenting stresses (Tamana et al., 2019).

This study characterized dysregulation broadly, including high levels of (i.e., under-controlled) reactivity and deficits in attentional and regulatory domains, consistent with Rothbart's psychobiological model of temperament and other theoretical conceptualizations of self-regulation and related functions (e.g., Diamond, 2013; Gartstein et al., 2016; Nigg, 2017). It should be noted that not all indicators of dysregulation considered as dependent variables in this study were associated with significant results. It may be that television exposure is less critical to reactivity associated with positive affectivity/approach, reflected in the surgency factor and the low intensity pleasure fine-grained dimension. Time watching TV also demonstrated variable predictive associations with regulation-related outcomes, and appeared most closely linked with soothability, but not overall effortful control, or its component scales. This pattern of results may be due to the relatively young age of the present sample, and the fact that soothability represents the most critical aspect of self-regulation, at least with respect to television exposure effects, in the toddler period.

With respect to cross-cultural differences, television exposure accounted for both within- and between-culture variance in the present study. Whereas the results for Negative Emotionality and emotional reactivity indicated that most of the TV exposure

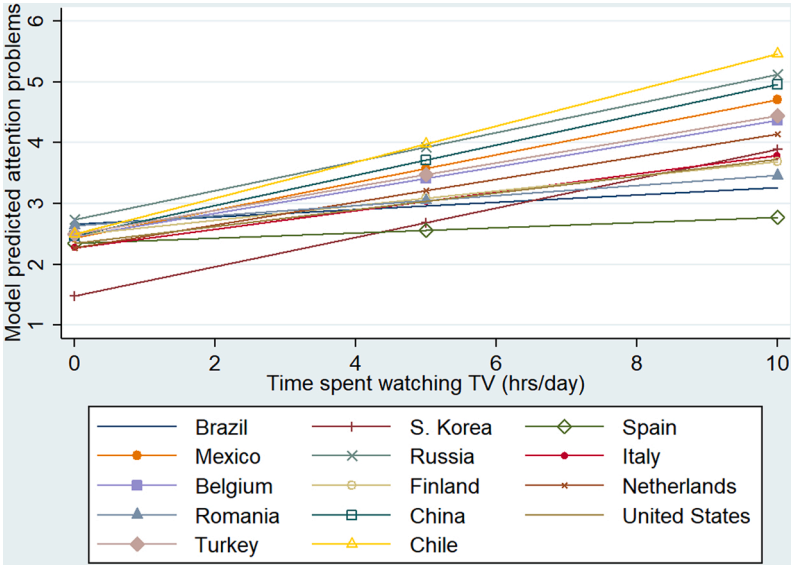

Fig. 2. Model implied ratings of attention problems predicted by time spent watching TV.

exclusively accounted for individual (i.e., within-level) variance, models for aggression, attention problems, and soothability revealed that TV exposure account for culture- and individual-level variance. That is, these models suggest that, at least a portion of observed cross-cultural differences in these variables might be explained by television exposure. Moreover, although greater dysregulation was associated with more extensive television exposure within individual cultures, the strength of this relationship varied significantly for both soothability and attention problems. That is, levels of child dysregulation were observed as a function of exposure, with lower soothability and more attention problems linked with time watching TV in some cultures (e.g., the Netherlands) and not others (e.g., Spain). As this aspect of the present investigation should be considered exploratory, given that a-priori hypotheses were not formulated due to the lack of prior research, conclusive interpretation awaits future investigations. However, it may be that some cultures offer protective mechanisms buffering against adverse effects of TV exposure. For example, Spanish families may be watching television together wherein TV-related activities constitute one element of family time, rather than relying on TV as "electronic babysitter" (Chassiakos et al., 2016), with this practice possibly stemming from the central theme of familismo, with strong attachment, loyalty, reciprocity, and solidarity among families, traditionally valued by individuals from Hispanic cultures (Diaz-Loving & Draguns, 1999). This protective effect possibility and others should be examined more closely in future research.

4.1. Limitations and future directions

The present study makes an important contribution to the existing literature but is not without limitations. This study uses cross-sectional data which limits the ability to examine the impact of television exposure on developmental projections. Future studies could utilize longitudinal methods to better understand the long-term associations of television and dysregulation, as well as begin to unravel causality in these associations. Furthermore, we only measured time spent watching TV, but it did not account for the content of the media that was being watched, nor the context in which television was viewed. Although some studies have indicated that certain content was associated with different outcomes (Borzekowski & Henry, 2011; Cole et al., 2003; Tomopoulos et al., 2007; Yang et al., 2017; Zimmerman & Christakis, 2007;), there is limited evidence for this differentiation in early childhood, as existing research has focused on older children. Thus, at present, most research would suggest that, with the exception of video chatting, media exposure prior to 18–24 months of age presents more risk than benefit (American Academy of Pediatrics, 2016). Nonetheless, assessing the content and context, as well as the quantity, of TV exposure in young children can increase our understanding of effects on development. Additionally, this study only examined television watching and did not address other media exposure, such as tablets and other electronic devices. Although this limitation should be addressed in future studies, television is still the most widely used media technology for the population of interest in this study, with cross-cultural exposure in early childhood (Kabali et al., 2015). Potential mediators of this observed relationship should also be explored in the future. For example, dysregulation may be more common in children with more TV exposure because they are consequently receiving fewer quality hours of sleep. Similarly, parental disciplinary strategies may be important to consider, as parents who set insufficient limits may allow for children with dysregulated temperament profiles to have disproportionately greater access to TV.

Our inability to assess some of the nuances associated with media exposure (e.g., the content of TV programming, the social context of TV watching, and exposure to different forms of media) is also relevant in considering effect sizes observed in the models presented herein. That is, estimated effect sizes can be described as small (Cohen, 1988), albeit consistent with effect sizes reported in other cross-cultural comparisons utilizing the ECBQ (e.g., Krassner et al., 2017; Slobodskaya et al., 2013), as well as temperament-related

studies more broadly (e.g., Gartstein et al., 2012). It is possible that with a more refined assessment of media exposure, larger and more robust effects could be elucidated, further underscoring the importance of expanding upon this research.

Importantly, future studies should include larger, more representative samples comprising a more extensive array of cultures, particularly critical for MLM analyses. That is, the statistical power of multilevel models is derived primarily from the number of highest-level units (i.e., cultures represented in the current study). As such, the power in this study was limited (J = 14), and a replication with a greater number of cultures would increase the precision of parameter estimates (by reducing standard errors) and increase confidence in the generalizability of findings, important given the relatively small effect sizes observed. Additionally, it is important to recognize that the majority of parents in this study reported that their children watch very little television, with most of the sample reporting that their toddlers do not watch television. As such, the skew and kurtosis for this variable were significantly non-normal. Although this represents a limitation of the current study, it is important to note that regression models are particularly robust against violation of normality with regard to dependent variables, thus this limitation is not expected to substantially diminish the significance of the present findings. Rather, this aspect of the data underscores the importance of assessing this relationship across other datasets and with populations that are likely to have greater television exposure. Another limitation is that our sample did not include children with clinical diagnoses; however, several disorders identified in the Diagnostic and Statistical Manual of Mental Disorder, Fifth Edition (DSM-5; American Psychiatric Association, 2013) are characterized by aspects of dysregulation (e.g., attention-deficit hyperactivity disorder, oppositional defiant disorder, autism spectrum disorder), and thus represent an important area for future research.

4.2. Conclusions

In conclusion, our study supports concerns that have been raised about early television exposure having lasting negative consequences for child development, demonstrating associations between early television exposure and emotional/behavioral dysregulation. However, these links were not all equivalent across all cultures, with some (i.e., the Netherlands) appearing conducive to greater negative effects of television exposure on soothability and attention problems than others (i.e., Spain). Our findings indicate that there is a cultural difference in the extent to which television may impact social-emotional development and, with further study, could provide insight into potential protective factors and avenues for possible preventative efforts. With media exposure steadily growing, it is imperative to understand how it impacts development and how these effects may be mitigated by cultural factors.

Author statement

All of the co-authors made substantive contributions to data collection and manuscript preparation, from conception of the project to the current revision. The first author was primarily responsible for the writing and the analytic activities with support from others, who also engaged in writing and interpretation of results for the initial manuscript and revisions.

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