Family Socioeconomic Status Moderates Associations Between Television Viewing and School Readiness Skills

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ABSTRACT: ***Objective:*** **We examined whether the negative relation between television viewing that exceeds the recommendations of the American Academy of Pediatrics (AAP) and school readiness varied by family income.** ***Methods:*** **Data were collected from 807 children from diverse backgrounds. Parents reported hours of television viewing, as well as family income. Children were assessed using measures of math, knowledge of letters and words, and executive function (EF).** ***Results:*** **Television viewing was negatively associated with math and EF but not with letter and word knowledge. An interaction between television viewing and family income indicated that the effect of television viewing in excess of the AAP recommended maximum had negative associations with math and EF that increased as a linear function of family income. Furthermore, EF partially mediated the relation between television viewing and math.** ***Conclusion:*** **Television viewing is negatively associated with children's school readiness skills, and this association increased as family income decreased. Active efforts to reinforce AAP guidelines to limit the amount of television children watch should be made, especially for children from middle- to lower-income families.**

(*J Dev Behav Pediatr 38:*233–239, 2017) **Index terms:** kindergarten, television, math, executive function, socioeconomic status, screen time.

The American Academy of Pediatrics (AAP) recommends that children older than 2 years watch no more than 1 to 2 hours of television per day.[1,2] However, studies consistently report that children watch more than the recommended amount and that parents are either unaware or unconcerned by this.[2,3] Given the prevalence of technology such as smartphones and tablets, engaging in screen time may be more frequent now than ever before.[1,4,5] Concerns about screen time are heightened by reports indicating concurrent negative associations between hours of television viewing and academic performance.[6,7] Finally, analyses of longitudinal data provide compelling evidence that television viewing during infancy and toddlerhood can undermine later academic achievement, above and beyond concurrent viewing.[8–10]

Although the association between television viewing and child development is increasingly well established, few if any studies of this association have considered aspects of the family context, such as socioeconomic status (SES), that might influence this association. Previous research has suggested that children in lower SES homes watch less educational and more entertainment programming than their more affluent peers.[11] This is troubling in that entertainment and developmentally inappropriate television viewing are negatively associated with the development of early academic skills.[12,13] In addition, parents in lower as opposed to higher SES homes may be less available because of work or other demands to effectively mediate children's media use. Consequently, this study tests the hypothesis that the association between television viewing and academic abilities in young children will vary by SES.

Furthermore, we examine executive function (EF) as a potential mechanism through which television viewing affects academic achievement.[14,15] Separate literature studies have established a negative association between television exposure and facets of EF, and among SES, EF, and early academic skills. Negative associations between television viewing and attention and behavioral problems commonly attributed to poor EF have been observed in correlational studies both in early childhood[16] and in adolescence.[17] Several studies have hypothesized that these associations may be partially explained by decrements in EF.[18] Relatedly, experimental studies have also linked elements of television programming to EF deficits in early childhood.[19,20] Extensive research has suggested that EF is critical for early learning, and has demonstrated that EF is positively associated with early math and literacy ability[21,22] and partially mediates that effect of SES on early academic ability.[23] It may be that children who spend more time watching television are likely to have worse EF, which in turn is related to lower academic achievement.

In light of emerging data that suggest that television exposure is negatively associated with early academic

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skills, we pose the following questions: (1) In a diverse sample of children entering school, is television viewing negatively associated with academic skills?; (2) Is the negative association of television viewing with academic readiness for school greater for children in low-SES homes?; we hypothesize that analyses will suggest a negative association of television viewing in children from all backgrounds, but that the negative association will be attenuated in children raised in higher-income contexts. (3) Finally, we examine whether EF is a mechanism by which television viewing affects academic skills. Given previous associations among SES, EF, television viewing, and academic outcomes, we expect that some of the negative effect of television viewing on academic skills may occur through negative effects of television viewing on EF.

METHODS

Participants

A sample of N = 807 children (405 female, M_{age} = 68.86 mo, SD = 4.07 mo) was recruited in fall of the kindergarten year in 2008 and 2009 to participate in a randomized controlled trial of an innovative educational curriculum. Families of students were notified by flyers distributed in schools and at parent night events. Data for the present analyses were collected in the fall of the kindergarten year, before the implementation of the curriculum. Children were seen by highly trained data collectors in 2 separate sessions approximately 2 weeks apart at the school in which they were enrolled. All data are analyzed cross-sectionally, as they result from assessment at a single time point. A post hoc power analysis reveals that a sample of this size with α error probability = .05 can detect a small effect (f^2 = 0.05) with power (1 − β error probability) = .998.

Measures

Academic Ability

Academic ability was measured using the Applied Problems and Letter-Word subtests of the Woodcock-Johnson III Tests of Achievement, a widely used and well-validated assessment of academic achievement. The reliability and validity of the Woodcock-Johnson are well established,[24] and independent reviews have found the Woodcock-Johnson to have good internal and external validity.[25] The Applied Problems subtest measures early math skills including counting, measurement, and basic verbal and nonverbal arithmetic operations. The Letter-Word subtest measures basic preliteracy skills including letter recognition and letter sounds.

Executive Function

All executive function (EF) measures were performed on a laptop computer, and collectively measured working memory, cognitive flexibility, and inhibitory control. These measures included the Hearts and Flowers task,[26] the Flanker task,[26] and the NIH Toolbox version of the Dimensional Change Card Sort Task (DCCS).[27] An EF composite was generated by averaging percent correct responding on each measure.

The Hearts and Flowers task has 3 blocks: in the first block—the hearts block—stimulus location and response location are congruent. In the second block—the flowers block—stimulus and response location are incongruent. In the third block, congruent (hearts) and incongruent (flower) trials are intermixed (total of 33 trials). Percent correct on mixed trials was used for analyses. Participants received instructional and practice trials before test trials on each block.

The DCCS also had instructional and practice trials, followed by a standard version of task, sorting images by color, then by shape. Finally, children were presented with 50 mixed trials in which instructions to sort by color or shape were presented auditorily. Percent correct on mixed trials was used.

The Flanker task showed children a row of 5 fish, and participants were instructed to press the button corresponding to the direction only the center fish was facing. Participants received instructional and practice trials before receiving test trials. Percent correct on all test trials was used.

General Intelligence

General intelligence was measured using Raven's Progressive Matrices test, a measure of fluid intelligence. Children were presented with a pattern for which 1 item is missing and asked to identify which of the 6 different options best completes the pattern.[28]

Television Viewing

Daily television viewing was obtained from parent responses to a single item that asked, "how many hours of TV or video does your child usually spend watching per day." The item was coded on an 8-point scale ranging from "none" to "more than 12 hours." This item did not specify platforms for viewing, but instead assessed time spent watching television and video programming on any device. This item captures a global measure of screen time, and has been used in previous investigations of the effects of television exposure.[8,9,29] This question was separate from another that asked about video game use, and a third that asked how many hours the television was typically on in the home during the day. In addition, data were collected in 2008 and 2009, before the widespread use of touchscreen devices such as the Apple iPad. Thus, only passive viewing, and not background television, any form of gaming (educational or not), or interactive screen-based technologies was investigated.

Income-to-Needs Ratio

Parents also reported monthly income and household size, which were used to calculate the income-to-needs ratio (INR). The INR is obtained by dividing annual household income by the federal poverty line adjusted for family size.

Covariates

Covariates in all analyses include child age in months at the time of testing, sex, and performance on Raven's progressive matrices.

Data Analysis Plan

Correlations are presented in Table 2 to show relations among predictor, outcome, and control variables. To address our first hypothesis that television viewing is negatively related to academic skills, we examined associations between television (and video) viewing and math, literacy, and EF in separate linear regression equations. To test our next hypothesis that the negative association between television viewing and school readiness will be greater for children in low-income homes, we added an interaction term between INR and television viewing to the regression models. Finally, to examine the hypothesis that EF accounts for some of the relationship between television and academic outcomes, we added EF to the regression equations predicting math and literacy. We then calculated the corresponding change in magnitude for the television viewing coefficient. In all models, coefficients represent the unique variance attributable to each variable, adjusted for all other variables in the model.

RESULTS

Missing Data

Nearly a third of the sample (31.6%) of the sample did not return questionnaires. Children in families not returning questionnaires had significantly lower Applied Problems ($t_{(720)} = 5.23$, $p < .01$), Letter-Word ($t_{(733)} = 4.74$, $p < .01$), and Raven's Progressive Matrices scores ($t_{(733)} = 2.52$, $p < .05$) and attended schools with higher rates of free and reduced lunch ($t_{(800)} = 4.66$, $p < .01$). Of those returning questionnaires (N = 552), 17.5% did not report income data. Among those participants who returned questionnaires, none of our variables of interest were associated with missing income data.

To account for missing data, all analyses used full information maximum likelihood (FIML) estimation. FIML takes into account the covariance matrix for all available data on the independent variables to estimate parameters and SEs. This approach provides more accurate estimates of regression coefficients than do listwise deletion or mean replacement.[30]

Descriptive Statistics

Correlations between each of the 3 executive function (EF) measures and the resulting EF composite are presented in Table 1. Descriptive statistics and bivariate correlations among variables used in analyses are presented in Tables 2 and 3, respectively. Daily television viewing is moderately negatively correlated with all analysis variables: nonverbal intelligence ($r = -.194$, $p < .01$), Letter-Word knowledge ($r = -.146$, $p < .01$), Applied Problems score ($r = -.250$, $p < .01$), income-to-needs ratio (INR) ($r = -.274$, $p < .01$), and EF ($r = -.183$, $p < .01$).

Table 1. Correlations Between EF Tasks and the EF Composite

Measure	1	2	3	4
1. Hearts and Flowers accuracy	—			
2. DCCS accuracy	.45[b]	—		
3. Fish Flanker accuracy	.39[b]	.39[b]	—	
4. EF composite	.81[b]	.78[b]	.80[b]	—

[a]$p < .05$. [b]$p < .01$. DCCS, Dimensional Change Card Sort Task; EF, executive function.

Is Television Viewing Negatively Associated with School Readiness?

In equations reported in Model 1 of Tables 4–6, daily hours of television viewing is significantly negatively associated with Applied Problems ($b = -3.06$, SE = 0.95, $\beta = -.13$, $p = .001$, 95% confidence interval [CI] [−0.20 to −0.07]) and EF ($b = -1.41$, SE = 0.77, $\beta = -.10$, $p = .06$, 95% CI [−0.15 to −0.11]), but not with Letter-Word scores ($b = -1.63$, SE = 1.65, $\beta = -.03$, $p = .47$, 95% CI [−0.11 to 0.03]). These associations were observed over and above effects for child age and nonverbal intelligence for all 3 outcomes, and for INR on Applied Problems ($b = 1.35$, SE = 0.30, $\beta = .21$, $p < .001$, 95% CI [0.15–0.30]), Letter-Word ($b = 2.83$, SE = 0.50, $\beta = .23$, $p < .001$, 95% CI [0.17–0.32]), and EF ($b = 0.57$, SE = 0.23, $\beta = .12$, $p = .013$, 95% CI [0.04–0.19]). Sex was not associated with any of the dependent variables.

Is the Negative Association of Television Viewing with School Readiness Greater for Children in Low Socioeconomic Status Homes?

In Model 2 of Tables 4–6, the interaction of hours of television viewing and INR significantly predicted Applied Problems ($b = 1.17$, SE = 0.37, $\beta = .14$, $p < .001$, 95% CI [0.12–0.36]) and marginally predicted EF ($b = 0.57$, SE = 0.30, $\beta = .09$, $p = .06$, 95% CI [0.02–0.27]).

Table 2. Descriptive Statistics

	Range	Mean	SD	N
Letter-Word Identification W Score	293–514	371.11	31.97	735
Applied Problems W Score	350–485	433.69	17.63	722
Raven's Progressive Matrices Score	0–12	8.11	1.86	735
Hearts and Flowers accuracy	0–97	68.07	18.27	681
DCCS accuracy	40–98	64.70	12.67	608
Fish Flanker accuracy	4–100	79.09	16.23	600
Income-to-needs ratio	0–13.76	3.44	2.77	461
Hours of television exposure	0–5	2.19	0.79	552
EF composite	25–96	68.85	0.14	731

DCCS, Dimensional Change Card Sort Task; EF, executive function.

Table 3. Correlations Among Study Variables

Measure	1	2	3	4	5	6	7
1. Letter-Word ID Score	—						
2. Applied Problems Score	.551[b]	—					
3. Hours of television	−.146[b]	−.250[b]	—				
4. Raven's Matrix Score	.301[b]	.373[b]	−.194[b]	—			
5. Age	.151[b]	.166[b]	−.091[b]	.167[b]	—		
6. INR	.291[b]	.315[b]	−.274[b]	.208[b]	.037	—	
7. EF composite	.393[b]	.562[b]	−.158[b]	.265[b]	.171[b]	.161[b]	—

[a]$p < .05$. [b]$p < .01$. EF, executive function; INR, income-to-needs ratio.

The interaction was unrelated to Letter-Word knowledge.

The interaction between family INR and television viewing in the prediction of math ability is presented in Figure 1. For families at the sample mean for INR, there was a moderate negative association between Applied Problems score and television viewing (b = −1.96, SE = 0.83, β = −.12, $p < .001$, 95% CI [−0.43 to −0.20]). A 1SD increase in television viewing (nearly an hour of viewing time and exceeding AAP guidelines) was associated with an approximate 3-point decline in Applied Problem scores. For families 1SD below the INR mean, which is at or near the federal poverty threshold in our sample, the decline in math scores associated with an SD increase in television viewing was large (b = −4.00, SE = 2.46, β = −.27, $p < .001$, 95% CI [−0.38 to −0.18]); nearly 6 points. For families 1SD above the INR mean, there was not a significant association between television viewing and math scores.

A similar pattern emerged for the prediction of EF, presented in Figure 2. Children in families with INR at the sample mean experienced a small and marginally significant decrease in EF scores for each SD increase in hours of television viewing, again marking a noticeable decrease in scores once the child has surpassed the AAP recommended amount of television viewing (b = −1.38, SE = 0.76, β = −.08, $p = .06$, 95% CI [−0.32 to −0.08]). For families 1SD below the sample mean, the negative association between television viewing and EF was moderate (b = −0.57, SE = 0.30, β = −.17, $p = .007$, 95% CI [−0.28 to −0.07]). Again, for families 1SD above the INR mean, there was no significant association between television viewing and EF.

Is the Association Between Television Viewing and Mathematics Accounted for in Part by Executive Function?

To test the hypothesis that EF accounts for some of the associations between television viewing and math skills, we included EF as an additional variable in the model estimating Applied Problems. Results in Model 3 of Table 5 indicate that EF was strongly related to math skills (b = 0.58, SE = 0.04, β = .44, $p < .001$, 95% CI [0.40–0.50]) and significantly partially mediated the association of television viewing with math ability (b = −1.94, SE = 0.74, β = −.09, $p = .012$, 95% CI [−.14 to −.03]).

DISCUSSION

Findings from this study of a diverse group of kindergarten participants are consistent with the previous literature: the number of hours of television young children watch predicts decrements in readiness for school. Notably, this was the first study to our knowledge to investigate whether associations of television viewing with school readiness indicators vary with household

Table 4. Regressions Predicting Letter-Word ID Scores

	Model 1: Main Effects			Model 2: Moderation			Model 3: Mediation		
Predictor	B	SE	β	B	SE	β	B	SE	β
Intercept	273.55[b]	20.42		277.33[b]	20.54		313.31	19.96	
Raven's Matrix Score	4.15[b]	0.67	.23	4.11[b]	0.67	.24	2.91[b]	0.65	.17
INR	2.83[b]	0.50	.23	3.00[b]	0.50	.26	2.58[b]	0.49	.22
Hours of TV	−1.63	1.65	−.03	−1.50	1.65	−.04	−0.44	1.57	−.01
Sex	0.92	2.23	−.01	0.86	2.22	.01	0.23	2.12	.00
Age	0.91[b]	0.29	.10	0.87[b]	0.29	.11	0.49	0.28	.06
TV–INR interaction				1.10	0.65	.07	0.72	0.62	.05
EF mean score							0.68[b]	0.08	.29

[a]$p < .05$. [b]$p < .01$. EF, executive function; INR, income-to-needs ratio.

Table 5. Regressions Predicting Applied Problems Scores

	Model 1: Main Effects			Model 2: Moderation			Model 3: Mediation		
Predictor	**B**	**SE**	**β**	**B**	**SE**	**β**	**B**	**SE**	**β**
Intercept	376.23[a]	11.00		380.61[a]	11.00		412.17	9.89	
Raven's Matrix Score	3.12[a]	0.40	.29	3.07[a]	0.39	.32	1.90[a]	0.35	.20
INR	1.35[a]	0.30	.21	1.54[a]	0.30	.24	1.25[a]	0.27	.21
Hours of TV	−3.06[a]	0.95	−.13	−2.88[a]	0.95	−.13	−1.96[b]	0.83	−.08
Sex	−1.17	1.20	−.03	−1.20	1.19	−.01	−1.63	1.04	−.05
Age	0.49[a]	0.16	.10	0.44[a]	0.16	.11	0.12	0.14	.02
TV–INR interaction				1.17[a]	0.37	.14	0.87[a]	0.33	.09
EF mean score							0.58[a]	0.04	.44

[a]$p < .01$. [b]$p < .05$. EF, executive function; INR, income-to-needs ratio.

income. We found that the association between television viewing and both early math and executive function (EF) was present among children regardless of household income, but that the strength of the association increased as household income decreased. Consequently, the association was largest and most educationally meaningful among children in low-income homes—in this sample, those at or near the federal poverty line (at time of data collection in 2008, around $21,200 per year for a family of 4). The association was strongest when children watched more than the 2 hours recommended by AAP guidelines. There was a small, yet still statistically significant and meaningful association for children whose parents reported income levels at the sample mean (approximately $74,200 per year for a family of 4). Finally, there was no association between television viewing and any school readiness indicator for children in high-income homes, as indicated by nonstatistically significant simple slopes for children whose parents reported income 1SD above the mean, or approximately 6 times the federal poverty line (approximately $127,200 per year for a family of 4).

Associations were specific to readiness as indicated by early math ability and EF. Unlike some previous studies,[8] we found no association between television viewing and preliteracy skills. It is possible that more television programming, especially educational programming, is targeted toward improving the literacy of young children. Previous investigations have found that some programming, such as Sesame Street, shows positive to neutral effects on children's literacy skills in a variety of contexts.[31] We cannot, however, investigate this possibility in our data, given the absence of information on the content of television programming.

Although our dataset contains no information on the types of programs to which children were exposed, nor the conditions under which children watched television, both are likely relevant to our findings. It may be that children in our sample in lower-income as opposed to higher-income homes are exposed to less educational and potentially enriching television content. Previous studies indicate family socioeconomic status (SES) is positively related to the proportion of educational and informational, versus entertainment, programming young children watch.[11] As well, certain types of television content have been shown to negatively impact conceptual skills. Lillard et al.[19] found that both the pacing and realism of television programs differentially affect children's performance on cognitive tasks, such that shows with more transitions that are less realistic (e.g., SpongeBob SquarePants) had more negative effects on child cognition than did more realistic shows with fewer transitions (e.g., Phineas and Ferb). It is likely that variation in the content and type of

Table 6. Regressions Predicting EF Composite

	Model 1: Main Effects			Model 2: Moderation		
Predictor	**B**	**SE**	**β**	**B**	**SE**	**β**
Intercept	13.33[a]	8.78		15.44[a]	8.59	
Raven's Matrix Score	1.67[a]	0.27	.23	1.65[a]	0.27	.23
INR	0.58[a]	0.23	.12	0.67[a]	0.24	.14
Hours of TV	−1.41[c]	0.77	−.08	−1.38[c]	0.76	−.08
Sex	1.05	0.96	.04	1.00	1.04	.04
Age	0.60[a]	0.12	.18	0.58[a]	4.63	.17
TV–INR interaction				0.57[c]	0.30	.09

[a]$p < .01$. [b]$p < .05$. [c]$p < .08$. EF, executive function; INR, income-to-needs ratio.

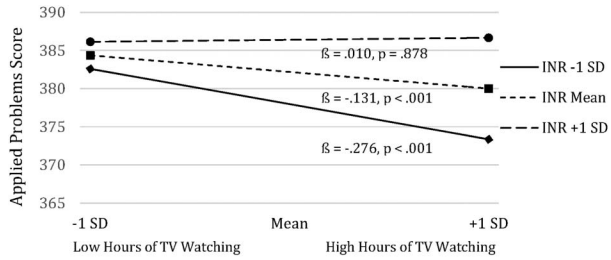

Figure 1. Family INR moderates the relation between television exposure and Applied Problems scores, holding all other covariates at their mean levels. INR, income-to-needs ratio.

programming associated with SES may affect children's academic performance directly as well indirectly through EF.[3,32]

An additional potential explanation concerns the context of television viewing. Parents in higher-income homes may be more likely to engage children in shared viewing, providing greater explanation and scaffolding to promote children's understanding and engagement. Minimal research has addressed this point in relation to television viewing: one study demonstrated that parent-child interaction decreases in both quantity and quality while the television is turned on in the home.[33] However, this could again relate to the content of television exposure: a separate study showed that mothers are more likely to interact and engage their child during educational versus noneducational programming.[34]

It is also important to consider that SES-related variation in the association between television viewing and child academic readiness for school may be due to a number of other factors that have been found to differentiate high- and low-SES home environments, including quality of parenting, conditions of the home environment, presence or absence of a secondary caregiver, material resources, and the time spent in other activities when not viewing television.[35] Time spent engaged in other enriching activities, such as book reading and pretend play, which tends to be greater in higher-income homes, may buffer negative effects of television viewing. For parents in middle- and lower-income homes, however, the choice may be one between enrichment or television viewing. As well, families with lower income may have more difficulty providing academically enriching material resources for use outside of the time during which children are

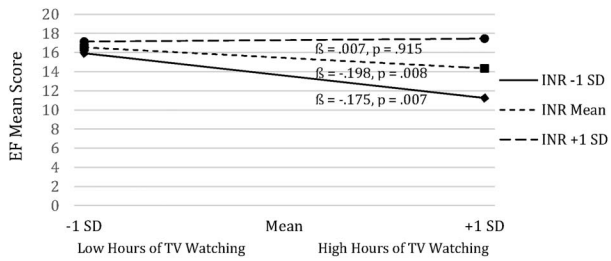

Figure 2. Family INR moderates the relation between television exposure and EF scores, holding all other covariates at their mean levels. EF, executive function; INR, income-to-needs ratio.

exposed to television[35] and television may displace other, potentially more enriching, activities.[15,36] However, it is also important to note that no single characteristic can accurately describe a population based on income; there is likely as much or more variation within income groups as between income groups as defined here.

Nonetheless, it is unlikely that television viewing is simply a marker for other aspects of children's experience that are unmeasured in our dataset. Hours of television viewing covaries only moderately with family income-to-needs ratio in our sample, suggesting that characteristics of television content and/or the context of viewing between higher- and lower-income homes are contributing to observed differences. It is likely that features of low-income households combine with television viewing to cumulatively affect school readiness.

Several limitations should be considered. First, the analysis is cross sectional and causality and directionality cannot be established. It is possible that children with more advanced math and EF skills choose to watch less or more academically enriching television. Second, we have no information on participants' activities outside of watching television, nor do we know the quality of children's interactions with parents and peers. Finally, our measure of television viewing behavior is a single item and provides no information on the content of programming or the context in which television viewing occurs. Asking about television viewing behavior in this way assumes that the child is watching television as their primary activity and assumes all content is created equal with regard to educational value. As such, it is likely the amount of television viewing in the present investigation is underreported.

School readiness is the foundation for future academic achievement,[37] as well as for later health and well-being.[8] Our findings indicate that the effect of television viewing on school readiness varies with family SES and is most pronounced in children that live in homes at or near the federal poverty line. Further research should examine the content and context of television viewing. It may be that content (e.g., type of programming) and context (e.g., with or without adult supervision) can explain some of the SES-related variation in the association between television viewing and academic ability observed here. For present purposes, however, findings demonstrate the need for more research to better understand the origin of the described findings, and a need to continue to reinforce the recommended AAP guidelines among parents, especially those in low- and middle-income homes. Existing structures such as Head Start and other early child care centers, as well as pediatricians' offices could represent excellent outlets for supporting parents in limiting television viewing.

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