CONTEMPORARY ECONOMIC POLICY

ARE TELEVISION AND VIDEO GAMES REALLY HARMFUL FOR KIDS?

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Are watching television (TV) and playing video games really harmful for children's development? By using a unique longitudinal dataset with detailed information on children's development and health, we examined the causal effect of hours of TV watched or of video games played on school-aged children's problem behavior, orientation to school, and obesity. The results suggested that the answer to the question is yes, but the magnitude of the effect is sufficiently small to be considered as negligible. The results were robust to within-twin-fixed effects. (*JEL* I10, I20)

I. INTRODUCTION

For young children, there are many benefits of watching television (TV) and playing video games. TV and video games provide very sophisticated entertainment environments using high-level technologies and graphics, which may stimulate many new thoughts and feelings in children by gaining knowledge to which they would never have been exposed in their own community. TV and video games can increase children's interest in and awareness of various social problems ranging from violence to natural disasters.

Apart from the benefits, many parents are concerned when their children spend much of their time in front of the TV or video games. There are numerous articles raising alarm over childhood exposure to TV or video games. For example, in the issue dated August 4, 2009, *TIME* headlined "Watching TV: Even Worse for Kids than You Think" and warned how sedentary behavior, such as watching TV or playing video games, has a strong influence on the obesity in young children. In the issue dated November 3, 2008, *CNN* broadcasted "Violent Video Games Linked to Child Aggression" and reported that children who were exposed to video games are more likely to exhibit out-of-control behaviors over time than those who were not. The widespread perception among people, especially parents, is that watching TV and playing video games have a negative influence on children's behavior, health, and cognitive

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ABBREVIATIONS

BMI: Body Mass Index
BPI: Behavior Problem Index
OLS: Ordinary Least Squares
OS: Orientation to School
TV: Television

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development; however, rigorous measurement of the effects is difficult owing to data and methodological limitations. Much policy debate on this topic hinges on more concrete and scientific evidence: the Government of Japan, including the Ministry of Education, Culture, Sports, Science and Technology and the Cabinet Office, has formed research committees and sought rigorous evidence on the effect of childhood exposure to TV or video games on outcomes such as violence and communication skills.

While much is known about the cross-sectional relationship between TV or video games and children's development, little is known about how children who actually spend more time in front of TV or video games would have developed if they had spent less time doing so. The observed differences in hours watching TV or playing video games may merely reflect, for example, differences in the extent to which children are allowed to watch more TV or play more video games, or in the extent to which children prefer to spend time alone instead of playing with their friends: a selection bias arises when part of the children's development can be explained by unobserved parental or child characteristics. The unobserved parental and child characteristics may be associated with a decrease in children's healthy development. In other words, observed correlations using cross-sectional data from previous literature, such as Christakis et al. (2004) and Zimmerman and Christakis (2005), do not provide a complete description of the effect of TV or video games and result in biased and inconsistent estimates. In this study, we wished to answer the question of whether differences in childhood exposure to TV and video games cause differences in children's development.

Given the considerable attention from the general public as well as policy circles who wish to identify the causes of children's development, understanding the effects of watching TV and playing video games may have significant implications. In this article, we examine the impact of watching TV and playing video games on three outcome measures of children's development: children's problem behavior, orientation to school (OS), and obesity. These measures are considered as strong predictors of subsequent outcomes, such as educational attainment and socioeconomic status, as suggested by numerous research studies (e.g., McLeod and Kaiser 2004; Miech et al. 1999).

This study aimed to go beyond the current literature on the causal relationship between TV or video games and children's development by using several methods. First, we estimated the ordinary least squares (OLS) while controlling for several parental and children's socioeconomic status. In addition, we employed the twin comparison approach, relating within-twin differences in hours of TV watched or video games played to differences in twins' development. Twins sharing the same (or similar) DNA pattern and growing up in the same household provide a control for genetic endowments as well as family environments. Moreover, we employed child fixed-effects models to control for time-variant unobserved heterogeneity across children and their parents.

After accounting for the selection of unobserved factors, does watching TV or playing video games have a negative effect on children's development? To answer this research question, this study took advantage of a nationally representative longitudinal dataset, collected from 2008 through 2010, to rule out unobserved heterogeneity and to isolate the pure effects of watching TV or playing video games on children's development.

The most significant finding of this paper is that, after addressing the potential bias, we find that the hours watching TV and playing video games have a negative impact on children's problem behavior, OS, and obesity; however, the magnitude of the effect is rather small. We then explore the nonlinear relationship between hours of TV watched or video games played and children's behavior and health. Moreover, according to the results, we find that the negative effects on children's problem behavior and obesity will dramatically increase by an excessive amount of exposure to TV or video games.

The remainder of this article is organized as follows. Section II reviews the relevant literature for establishing unknown information and explains how we tackled the methodological problems in previous research. Section III introduces the methodology and empirical specifications for estimation, identifies the potential bias emerging in the econometric analysis, and determines the analytical techniques for obtaining unbiased estimates of the impact of TV or video games on children's development. Section IV describes the data used in our empirical analyses and the coded variables. Section V presents the empirical results. In Section VI, we present our conclusions.

II. RELEVANT LITERATURE

In this section, we survey the previous literature concerning the link between childhood exposure to TV and children's development. Numerous studies on the effect of TV and video games exist in the fields of medical science, psychology, and social sciences, which may be classified into three lines of research. First, certain correlational studies, mostly in medical science, have provided considerable evidence for the negative effect of TV and video games on various outcomes for children (e.g., Christakis et al. 2004; Gortmaker et al. 1996; Hancox, Milne, and Poulton 2005; Hornik 1981; Keith et al. 1986; Morgan and Gross 1980; Sharif and Sargent 2006; Van Schie and Wiegnman 1997; Zimmerman and Christakis 2005). While these studies examined several outcomes, they reached a consensus on the effect of the TV and video game exposure: the findings generally support a negative and significant relationship. However, one may be skeptical about assuming this relationship to be causal. These correlations might be due to other unobserved characteristics of parents or children that are associated with poorer outcomes.

Therefore, recent research has focused on the causal question. The second line of research, mostly in social sciences, uses longitudinal datasets and attempts to address the causal inference. However, the results of these studies are quite mixed. Using a nationally representative longitudinal dataset, Aksoy and Link (2000) and Huang and Lee (2010) found that watching TV has a negative effect on cognitive development. Contrary to these findings, other studies found no association between hours of TV watched and children's outcomes (Gaddy 1986; Gortmaker et al. 1990; Munasib and Bhattacharya 2010; Zavodny 2006). Chou, Rashad, and Grossman (2008) showed that early childhood exposure to fast-food restaurant advertisement on TV was associated with obesity.

Third, some studies involved the exploitation of heterogeneity in the timing of the introduction of TV programs or video game stores to develop instruments. Gentzkow and Shapiro (2008) utilized the randomness of the introduction of TV in the United States during 1948–1954 and found that childhood TV exposure had a positive impact on standardized test scores later in life, which was greater for individuals from sociodemographically disadvantaged families. Ward (2012) utilized the availability of popular video games, which is not related to selection but strongly related to the time spent on video games, and found that an additional hour of video game playing was associated with decrease in educational activities, such as doing homework. In more recent research, Ward (2011) also found that video gaming is associated with significant reduction in crime and death rates.

Our empirical strategy followed the protocol of the second line of research, such as Zavodny (2006) and Munasib and Bhattacharya (2010). We used the nationally representative longitudinal dataset collected by the Government of Japan to study the effect of TV or video games on children.[1] This study makes several contributions to understanding the effect of watching TV or playing video games on children's outcomes: (a) it focuses on early childhood, which is relatively unexplored in the previous literature; (b) it examines children's behavior, social integration, and health as outcomes, which are strong predictors of educational attainment and an individual's socioeconomic status later in life; and (c) it takes advantage of a unique longitudinal dataset to control for unobserved variations in child and family characteristics that tend to bias OLS estimates.

III. METHODOLOGY

To address our research question of whether TV or video games affect children's development, we begin with an analysis using OLS estimates to confirm the results drawn from much previous research, where researchers have

1. This paper is more focused on the "amount" of television watched or video games played; however, as reported by Huston and Wright (1998) and Kirkorian, Wartella, and Anderson (2008), the "content" of media is an important determinant of children's outcomes. One of the biggest drawbacks of our dataset is that there is no information about the content of television or video games. Therefore, we attempted to control for differences in the content of media by including several variables, such as parental education, time spent alone after school, and whether the child lived with grandparents. These control variables are likely to be correlated with the contents of media chosen through caregivers' attention to and observation of children's activities at home. Moreover, there is a justification for using the time spent on television: in Japan, contrary to the United States, regular broadcasting is more popular than cable or satellite, for geographical reasons (Ministry of Internal Affairs and Communications 2013). There are, at most, only seven channels, in which the contents appear to be very homogenous. There are smaller variations in the contents of television programs, especially for early elementary school children, reflecting the decreased numbers of young population.

shown negative correlations. The model can be formally expressed by the following mathematical equation, where y_{it} is the outcome, T_{it} is the number of hours of TV watched, V_{it} is the number of hours of video games played, and X_{it} is a vector of individual-level socioeconomic and demographic control variables. We include both the TV and video game variables in the same regression model because the number of hours of TV watched and video games played are weakly but positively correlated (the more children watched TV, the more they played video games, and vice versa).

$$y_{it} = X_{it}\beta + \gamma T_{it} + \delta V_{it} + \varepsilon_{it}. \tag{1}$$

In the OLS estimate, the coefficient for T_{it} or V_{it} is interpreted as the effect of child i's exposure to TV or video games at time t, holding all other observed factors constant. However, the observed differences in the hours watching TV or playing video games may simply reflect differences in the kind of parents who allow children to spend more time on TV or video games or in the kind of children who are more likely to spend time alone instead of playing with their friends. These unobserved parental and child characteristics may be associated with the reduction of children's emotional well-being. If a selection on unobserved characteristics is present, Equation (1) may be subject to omitted variable bias and yield inconsistent estimates of the effect of watching TV or playing video games.

Fixed- and random-effect models enable us to control for time-invariant unobservables that affect both dependent and key independent variables. The models also enable us to answer the question of whether differences in childhood exposure to TV and video games *cause* differences in children's development. In particular, the fixed- and random-effect models incorporate an individual-specific time-invariant factor, A_i, as specified in Equation (2).

$$y_{it} = X_{it}\beta + \gamma T_{it} + \delta V_{it} + A_i + v_{it} \tag{2}$$

where $\varepsilon_{it} = A_i + v_{it}$, v_{it} is an idiosyncratic error term that is assumed to be independent of other terms in the equation. If we can be sure that A_i is not correlated with all independent variables and is normally distributed, then the random effects model would be appropriate. However, if A_i is correlated with an independent variable, the fixed-effects model would be appropriate. If a random-effects model was used, the estimators would be generally inconsistent, making it possible to confirm that unobserved heterogeneity biases the random-effects result. The choice of model is based on the Hausman specification test, as first proposed in Hausman (1978). The time-invariant unobservables can be eliminated by taking time-demeaned transformation induced by repeated observations on the same individual, yielding

$$(y_{it} - \overline{y_i}) = (X_{it} - \overline{X_i})\beta + \gamma(T_{it} - \overline{T_i}) + \delta(V_{it} - \overline{V_t}) + v_{it}. \tag{3}$$

IV. DATA

The data used in our empirical analysis were drawn from the Longitudinal Survey of Babies in the 21st Century, a longitudinal dataset organized in nine waves, collected by the Japanese Ministry of Health, Labour and Welfare between 2001 and 2010. Despite random sampling, the survey is complete, which targeted all 53,575 newborn babies in Japan born during January 10–17 and July 10–17, 2001. Because there is no systematic or seasonal pattern in the population of births, shown in the monthly Vital Statistics collected by the Ministry of Health, Labour and Welfare, this dataset can be considered representative. The respondents were primary caregivers, mostly parents. From Waves 1 through 6, the surveys were conducted 6 months postpartum on August 1, 2001 and February 1, 2002. One and a half years after Wave 6, Waves 7 through 9 were conducted on January 18 and July 18, indicating that the subjects in these waves reached school age in the same grade (G1 through G3) at the time of the survey. The unique characteristic of these data is that they include samples of twins and triplets, although no information is provided to identify whether each twin or triplet is monozygotic or dizygotic.

The response rate for each wave was, on average, 90%. Of the total, 75% of the initial sample completed the questionnaire for the final wave, indicating that the response rates remained very high. In addition to the overall low level of data attrition, as pointed out by Kitamura (2013), attrition bias is not a serious concern in our study. As the respondents in this survey were primary caregivers, mostly mothers, the reason why they stopped responding to the survey may be unrelated to their children's development.

In this article, we used three consecutive waves, from Waves 7 to 9, which provide a

detailed series of questions about the everyday behaviors of children, both at home and at school, about which parents/primary caregivers are particularly concerned. Because the children targeted in these waves were of primary school age, their behaviors may be more clearly observed by parents/primary caregivers in a process where children establish relationships with others. Our sample was restricted to children whose parents were both Japanese, because children of immigrants, though small in number, may more likely have different educational backgrounds, such as international or ethnic schools.

One of our main outcomes was defined as the behavior problem index (BPI), originally developed by Peterson and Zill (1986), which has been commonly used by researchers to measure children's socioemotional adjustment and well-being. In this study, BPI consisted of 19 behavior problem items reported by parents/primary caregivers, such as using violent language, telling lies, and fighting with friends. It is important to note that the original survey included 20 behavior problem items, but we excluded the item regarding TV or video games: "Spends many hours watching TV or playing video games" to rule out the potential endogeneity that would result from including watching TV or playing video games within the measure of problem behavior.[2]

BPI listed 19 items and asked respondents to check all items that were applicable to them. Each item was coded as 1 if the respondent checked it and 0 otherwise. (The items comprising BPI are listed in Table A1 of the Appendix.) The BPI score was then calculated as the sum of all items checked, ranging from 0 to 19: the higher the BPI score, the greater the children's behavior problems. As shown in Table 1, the mean BPI score during the three consecutive waves was 1.770 for boys, with a standard deviation of 1.688, and 1.498 for girls, with a standard deviation of 1.532.

The second outcome was defined as the OS, which attempts to measure student attitude and motivation toward school and learning, as originally conceptualized by Jessor et al. (1995). OS comprised five items of children's feeling or attitude toward school as observed by parents/primary caregivers. Each item was coded as -1 if the respondent answered yes, 1 if s/he answered no, and 0 if s/he answered neither yes nor no (items comprising OS are also listed in Table A1 of the Appendix). The OS score was then calculated as the sum of all items coded, ranging from -5 to 5. Many studies suggest that OS is a strong predictor of educational attainment and student achievement (Fall and Roberts 2012; Ladd & Dinella 2009; Li and Lerner 2011). The larger the OS score, the more children exhibit negative attitudes toward school. As shown in Table 1, the mean OS score during the three consecutive waves was -3.944 for boys with a standard deviation of 1.456 and -4.170 for girls with a standard deviation of 1.299.

The third outcome was childhood obesity, which was measured by the body mass index (BMI), defined as weight in kilograms divided by height in meters squared. Many studies have suggested that watching TV and playing video games are strongly associated with obesity and will continue into maturity (e.g., Lumeng et al. 2006). This line of medical research revealed that childhood obesity is a risk factor for several adult health problems, such as a high level of cholesterol (e.g., Wright et al. 2001). Overall, childhood obesity is a strong predictor of adult health status, which is an important component of an individual's human capital. As shown in Table 1, the mean BMI during the three consecutive waves was 16.026 for boys with a standard deviation of 2.168 and 15.755 for girls with a standard deviation of 2.039. These indicators do not vary across early elementary children in comparison with teenage children. However, we must emphasize the importance of detecting signs of behavioral and health problems while children are still very young because such problems are more likely to continue into the teens and sometimes even into adulthood (Drotar 2004).

The key independent variables of interest were the average daily hours of TV watched and of video games played. More precisely, we calculated the average hours of TV watched or video games played between weekdays and

2. We calculated the correlations between this item coded as 1 if the respondent answered yes and 0 otherwise, and the reported hours of television watched and video games played. These variables were highly correlated (0.779 for television and 0.834 for video games). It can be said that there is little concern about measurement errors in the reported hours of television watched or video games played.

TABLE 1
Variable Description and Summary Statistics

Variable Description	Boys [All] Mean (SD)	Boys [Low] Mean (SD)	Boys [High] Mean (SD)	Girls [All] Mean (SD)	Girls [Low] Mean (SD)	Girls [High] Mean (SD)
Dependent variables						
BPI	1.770	1.595	1.879	1.498	1.346	1.593
	(1.688)	(1.588)	(1.739)	(1.532)	(1.452)	(1.572)
OS	−3.944	−3.997	−3.911	−4.170	−4.234	−4.130
	(1.456)	(1.441)	(1.465)	(1.299)	(1.259)	(1.321)
BMI	16.026	15.791	16.173	15.755	15.494	15.917
	(2.168)	(1.967)	(2.273)	(2.039)	(1.856)	(2.128)
Key independent variables						
Hours of television watched a day	2.017	1.251	2.505	2.020	1.222	2.522
	(0.893)	(0.286)	(0.802)	(0.917)	(0.315)	(0.809)
Hours of video games played a day	1.062	0.888	1.172	0.715	0.557	0.814
	(0.725)	(0.655)	(0.746)	(0.613)	(0.545)	(0.633)
Control variables						
(i) Family structure						
Number of siblings	1.239	1.223	1.249	1.218	1.193	1.233
	(0.774)	(0.764)	(0.780)	(0.763)	(0.754)	(0.768)
Number of grandparents	0.378	0.339	0.402	0.370	0.342	0.386
	(0.727)	(0.703)	(0.741)	(0.718)	(0.703)	(0.727)
(ii) Parental socioeconomic status						
Mother's employment status (reference = not working)	0.392	0.423	0.373	0.394	0.426	0.373
1 = full-time	0.183	0.175	0.188	0.186	0.182	0.189
2 = part-time	0.362	0.335	0.379	0.360	0.329	0.380
3 = self-employed	0.062	0.067	0.059	0.060	0.063	0.058
Father's employment status (reference = not working)	0.011	0.010	0.011	0.012	0.011	0.013
1 = full-time	0.836	0.840	0.834	0.843	0.846	0.841
2 = part-time	0.008	0.008	0.008	0.009	0.008	0.010
3 = self-employed	0.145	0.142	0.146	0.136	0.135	0.136
(iii) Lifestyle habits						
Having breakfast every day (reference = not at all)	0.973	0.983	0.967	0.974	0.984	0.968
	(0.161)	(0.129)	(0.177)	(0.158)	(0.126)	(0.175)
Hours of sleep per day	9.227	9.295	9.184	9.215	9.291	9.167
	(0.538)	(0.526)	(0.541)	(0.546)	(0.528)	(0.551)
Hours spent alone	0.423	0.374	0.453	0.415	0.369	0.443
	(0.676)	(0.611)	(0.711)	(0.645)	(0.589)	(0.677)
Number of observations	39,051	39,051	39,051	35,924	35,924	35,924

Source: Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

weekends.[3] We also controlled for various child or parental socioeconomic and demographic variables corresponding to (a) parental socioeconomic status, such as parental employment status;[4] (b) family structure, such as the number of siblings and whether children lived with their grandparents; and (c) children's lifestyle and time spent, such as breakfast, sleeping routine, and time spent alone after school.

3. The response category in the original questionnaire ranged from 1 (=no television or video games) through 6 (over 6 hours). We set the minimum at zero and maximum at 6 hours. Then, we took the median value for categories between 2 (0.5 = less than 1 hour) and 5 (5.5 = 5–6 hours).

4. The survey includes parental income and parental educational backgrounds only in Wave 7. We estimate OLS with those socioeconomic status variables using data in Wave 7, but the results are quite similar reported in Tables 2–4.

Some control variables deserve further comment. One cannot always determine a priori the direction of the impact of family structure on outcomes: the numbers of siblings could have both positive and negative effects, as does whether children live with their grandparents. The mechanism for fewer siblings having a positive effect on children's development is that parents can allocate more household resources or attention toward each child, and children are less often forced to assist in running household errands. However, previous research has found that the larger the family size, the faster children's scholastic progress, because older siblings are often available to help the younger children with their homework (Bianchi and Robinson 1997).

The effect of children living with their grandparents on outcomes is also ambiguous. Sometimes children may receive extra support and attention from grandparents, increasing children's well-being at home. However, they may become confused and unstable owing to the death or illness of grandparents, if they have a strong emotional attachment toward them. Thus, the total effect is unclear a priori and is a question to be resolved empirically. Hofferth and Standberg (2001) pointed out that having breakfast at home regularly may be associated with a more stable and organized family life, and thus with children having fewer behavior and health problems. Further, sleeping routine seems to be crucially important for children's development, as shown by Sekine et al. (2002). Thus, we included a set of control variables in our estimates that represent breakfast and sleeping routine. In addition, all regressions include survey year fixed effects.

The descriptive statistics summarized in Table 1 show that the average male child in the sample was raised within a nuclear family; on a daily basis, he watches TV for 2 hours and plays video games for 1 hour, whereas he sleeps for 9 hours and spends 30 minutes alone; his father was currently engaged in full-time work, whereas his mother was not working outside the home. The two right-hand columns in Table 1 (noted as [Low] or [High]) illustrate how much each of the variables differed between children who were above or below the median in terms of how many hours they spent in front of TV (= 1.785 hours a day). On observing the coefficients, the most important finding is that children who watched more TV also played more video games, leading us to include both TV and video game variables in the same specification. We also found that children who watch TV longer were from households with lower-income and less-educated parents than their counterparts; their mothers were working and thus they spent more time alone at home after school. Table 1 also presents the descriptive statistics for the average female child in the sample. Although the hours of video game playing were slightly lesser for girls, the rest of the characteristics were quite similar for both boys and girls. The differences between children above and below the median in TV hours also did not vary by gender.

V. EMPIRICAL RESULTS

A. Problem Behavior

We first estimated the conventional OLS shown in Equation (1) to measure the effect of hours of TV watched or video games played on children's problem behavior, holding numerous parental socioeconomic factors constant. As illustrated in the first columns for each gender of Table 2, the results, coupled with the positive coefficient for TV and video games, suggest that the hours of TV watched were correlated with problem behaviors of both male and female children, although the coefficient for video games was statistically significant only for females. The coefficient for TV means that each additional hour of TV watched was associated with increases in BPI score of 0.156 for boys and 0.159 for girls and each additional hour of video gaming was associated with a 0.086 increase in BPI scores for girls. Therefore, TV and video games, on average, worsen emotional well-being. The magnitude of the effect is that one additional hour of TV watched increased BPI by approximately 10% of its standard deviation and one additional hour of video games played increased it by approximately 4% of its standard deviation, which is quite a large effect. With respect to changes in the impacts of other control variables, the presence of siblings was negatively correlated with BPI. Breakfast and sleeping routines did reduce the child's behavior problems. The more hours children spent at home alone after school, the more they exhibited serious problem behaviors. However, the standardized coefficients for children's lifestyle variables were not as large as those for TV and video games, indicating that parental involvement in children's lifestyle

TABLE 2
Dependent Variable: Behavior Problem Index

	Boys		Girls	
	OLS	**FE**	**OLS**	**FE**
Key independent variables				
TV	0.173***	0.064***	0.135***	0.055***
	(0.010)	(0.014)	(0.009)	(0.014)
Video games	0.065	0.037**	0.057***	−0.005
	(0.013)	(0.017)	(0.014)	(0.017)
Control variables				
Siblings	−0.153***	0.142**	−0.114***	0.045
	(0.011)	(0.053)	(0.010)	(0.051)
Grandparents	0.062***	0.058	0.010	0.001
	(0.012)	(0.035)	(0.011)	(0.037)
Mother's employment status (reference = not working)				
Full-time	−0.132***	−0.060	−0.056**	0.062
	(0.023)	(0.055)	(0.022)	(0.052)
Part-time	−0.116***	−0.009	−0.063***	0.014
	(0.019)	(0.028)	(0.017)	(0.027)
Self-employed	−0.231***	−0.009	−0.090**	0.078
	(0.039)	(0.061)	(0.037)	(0.062)
Father's employment status (reference = not working)				
Full-time	0.039	0.011	−0.140*	−0.074
	(0.075)	(0.083)	(0.074)	(0.087)
Part-time	0.260**	−0.053	0.155	0.065
	(0.114)	(0.127)	(0.116)	(0.128)
Self-employed	0.003	−0.081	−0.158**	−0.144
	(0.078)	(0.095)	(0.077)	(0.097)
Having a breakfast	−0.684***	−0.014	−0.796***	−0.273***
	(0.066)	(0.064)	(0.063)	(0.064)
Hours of sleep per day	−0.045***	−0.026	−0.044***	−0.021
	(0.016)	(0.022)	(0.015)	(0.021)
Hours spent alone	0.170***	0.046**	0.121***	0.018
	(0.014)	(0.015)	(0.014)	(0.015)
Year fixed effects (reference = 2008)				
2009		0.010		0.083***
		(0.015)		(0.014)
2010		−0.115***		−0.014
		(0.016)		(0.016)
Constant	2.572***	1.662***	2.620***	1.810***
	(0.183)	(0.241)	(0.173)	(0.236)
Number of observations	39,051	39,051	35,924	35,924

Note: Parentheses in the table indicate heteroskedasticity-robust standard errors. FE, fixed effects.

***Statistically significant at a 1% level; **statistically significant at a 5% level; and *statistically significant at a 10% level.

Source: Authors' calculations from the Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

partly offsets the negative effect of TV and video games. These findings did not vary by gender.

The second and fourth columns of Table 2 provide estimates from the fixed-effects model. The results show that the coefficients for hours of TV watched were statistically significant and dropped to 0.064 for boys and 0.055 for girls. Meanwhile, the coefficient for video games played also became statistically significant for boys, rising to 0.037, but became statistically insignificant for girls. We can still maintain our argument that TV and video games have negative effects, but the magnitudes became dramatically smaller after controlling for time-invariant child and parental unobserved characteristics. More specifically, the magnitude of the effect is that one additional hour of TV watched increased BPI by approximately 4% of its standard deviation and one additional hour of video games played increased it by approximately 2% of its standard deviation, which is a much smaller effect as compared with OLS estimates.

The coefficients for other control variables are almost the same as the results from the conventional OLS. However, the effect of the numbers of siblings in fixed effects was the opposite: the more siblings, the fewer a child's problem behaviors, particularly for male children, implying that parental attention or resources might be distributed among the children. In relation to the lifestyle variables, only the coefficients for time spent alone at home after school for boys and for having breakfast for girls were statistically significant. Although we also ran the random-effects model, which provides similar results to the fixed-effects model, according to the Hausman specification test, the model of choice was the fixed-effects model. To summarize, the fixed-effects estimates suggest that the magnitude of hours of TV watched dropped by a third to a half according to OLS estimates, while the coefficient for hours of video games was indistinguishable from zero, in particular for girls.

The empirical results in this paper assume that the relationships between hours of TV watched or video games played are linear with children's outcomes; however, many studies suggest that the effect is not linear (Zavodny 2006; Munasib and Bhattacharya 2010). Furthermore, because opposing TV or video games is very difficult for parents today, they may be more interested in the extent to which TV or video games are significantly harmful to children, rather than whether they are harmful. Does the negative effect increase with the time spent watching TV or playing video games? To answer this question, we conducted separate regressions, with the same covariates used in Tables 2 through 4, to check for the cumulative effect of TV and video games. The results,

TABLE 3
Dependent Variable: Orientation to School

	Boys		Girls	
	OLS	**FE**	**OLS**	**FE**
Key independent variables				
TV	0.024***	0.018	0.047***	0.044**
	(0.009)	(0.013)	(0.008)	(0.013)
Video games	0.185***	0.052**	0.128***	0.048**
	(0.011)	(0.016)	(0.012)	(0.016)
Control variables				
Siblings	−0.063***	0.015	−0.058***	0.002
	(0.009)	(0.048)	(0.009)	(0.047)
Grandparents	−0.040***	0.004	−0.014	0.025
	(0.010)	(0.034)	(0.009)	(0.031)
Mother's employment status (reference = not working)				
Full-time	−0.161***	0.015	−0.187***	0.064
	(0.020)	(0.052)	(0.018)	(0.050)
Part-time	−0.049***	0.007	−0.005	0.023
	(0.016)	(0.026)	(0.015)	(0.025)
Self-employed	−0.100***	0.001	−0.061*	−0.012
	(0.033)	(0.052)	(0.032)	(0.068)
Father's employment status (reference = not working)				
Full-time	−0.135*	0.080	−0.091	−0.103
	(0.078)	(0.088)	(0.063)	(0.071)
Part-time	−0.039	−0.198	0.165	−0.100
	(0.120)	(0.133)	(0.104)	(0.118)
Self-employed	−0.100	0.076	−0.034	−0.069
	(0.081)	(0.097)		(0.085)
Having a breakfast	−0.514***	−0.100	−0.337***	−0.138**
	(0.058)	(0.063)	(0.052)	(0.061)
Hours of sleep per day	−0.079***	−0.027	−0.084***	−0.021
	(0.014)	(0.021)	(0.013)	(0.020)
Hours spent alone	0.069***	0.024*	0.026**	0.024*
	(0.012)	(0.014)	(0.012)	(0.015)
Year fixed effects (reference = 2008)				
2009		0.058***		0.045**
		(0.014)		(0.013)
2010		0.087***		0.121***
		(0.016)		(0.015)
Constant	−2.732***	−3.870***	−3.078***	−3.978***
	(0.165)	(0.239)	(0.145)	(0.219)
Number of observations	39,051	39,051	35,924	35,924

Note: Parentheses in the table indicate heteroskedasticity-robust standard errors. FE, fixed effects.

***Statistically significant at a 1% level; **statistically significant at a 5% level; *statistically significant at a 10% level.

Source: Authors' calculations from the Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

TABLE 4
Dependent Variable: Body Mass Index

	Boys		Girls	
	OLS	**FE**	**OLS**	**FE**
Key independent variables				
TV	0.243***	0.053***	0.223***	0.030**
	(0.014)	(0.014)	(0.013)	(0.014)
Video games	0.104***	−0.019	0.162***	−0.016
	(0.018)	(0.016)	(0.020)	(0.017)
Control variables				
Siblings	−0.048***	−0.067	−0.006	−0.030
	(0.015)	(0.054)	(0.015)	(0.047)
Grandparents	0.135***	0.014	0.112***	−0.053
	(0.017)	(0.040)	(0.017)	(0.056)
Mother's employment status (reference = not working)				
Full-time	0.145***	−0.019	0.253***	0.024
	(0.033)	(0.059)	(0.033)	(0.060)
Part-time	0.034	−0.029	0.048**	0.013
	(0.025)	(0.027)	(0.024)	(0.030)
Self-employed	0.122**	−0.112*	0.231***	−0.042
	(0.055)	(0.067)	(0.057)	(0.066)
Father's employment status (reference = not working)				
Full-time	−0.124	0.006	−0.156	−0.040
	(0.121)	(0.080)	(0.121)	(0.087)
Part-time	−0.071	0.057	−0.211	0.096
	(0.172)	(0.117)	(0.179)	(0.125)
Self-employed	−0.101	0.015	−0.048	−0.047
	(0.125)	(0.100)	(0.126)	(0.101)
Having a breakfast	0.107	0.108*	−0.097	0.067
	(0.080)	(0.064)	(0.085)	(0.065)
Hours of sleep per day	−0.343***	−0.062**	−0.253***	−0.031
	(0.022)	(0.022)	(0.021)	(0.021)
Hours spent alone	0.044**	0.031**	0.090***	0.019
	(0.019)	(0.014)	(0.019)	(0.016)
Year fixed effects (reference = 2008)				
2009		0.351***		0.308***
		(0.014)		(0.014)
2010		0.882***		0.721***
		(0.017)		(0.017)
Constant	18.573***	16.059***	17.629***	15.647***
	(0.260)	(0.248)	(0.252)	(0.236)
Number of observations	39,051	39,051	35,924	35,924

Note: Parentheses in the table indicate heteroskedasticity-robust standard errors. FE, fixed effects.

***Statistically significant at a 1% level; **statistically significant at a 5% level; *statistically significant at a 10% level.

Source: Authors' calculations from the Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

shown in Table 5 for fixed-effects estimates, show that the quadratic terms for TV and video games were not statistically significant, although the dummy variables for the categories of TV watching and video game playing (reference = 0 hour; 1 = less than 1 hour; 2 = 1–2 hours; 3 = 2–3 hours; 4 = 3–4 hours; 5 = 4–5 hours; 6 = 5–6 hours; and 7 = more than 6 hours) were statistically significant for 2–6 hours of TV watching and the magnitude became larger with additional hours of TV watching. This indicates that the negative effect of the first hour is indistinguishable from zero, or relatively small. In other words, the negative

TABLE 5
Nonlinear Relationship (Both Boys and Girls)

	BPI		OS		BMI	
	Model I	**Model II**	**Model I**	**Model II**	**Model I**	**Model II**
TV	0.074**		0.055*		0.009	
	(0.032)		(0.029)		(0.031)	
Quadratic in TV	−0.002		−0.005		0.006	
	(0.006)		(0.005)		(0.006)	
Video games	0.008		0.018		−0.045**	
	(0.022)		(0.021)		(0.022)	
Quadratic in video games	0.004		0.013		0.011	
	(0.009)		(0.009)		(0.009)	
TV (reference = no TV)						
Less than an hour		0.069		0.031		0.058
		(0.044)		(0.042)		(0.043)
1-2 hours		0.085*		0.052		0.062
		(0.046)		(0.043)		(0.045)
2-3 hours		0.122**		0.087**		0.097**
		(0.048)		(0.045)		(0.047)
3-4 hours		0.190***		0.082		0.103**
		(0.053)		(0.050)		(0.052)
4-5 hours		0.208***		0.153**		0.215***
		(0.067)		(0.066)		(0.068)
5-6-hours		0.308**		0.181*		0.239**
		(0.126)		(0.103)		(0.120)
More than 6 hours		0.127		0.176		0.340
		(0.242)		(0.164)		(0.209)
Video games (reference = no video games)						
Less than an hour		0.016		0.015		0.030**
		(0.014)		(0.013)		(0.013)
1-2 hours		0.012		0.059***		−0.027
		(0.021)		(0.020)		(0.021)
2-3 hours		0.079		0.132***		0.004
		(0.049)		(0.047)		(0.048)
3-4 hours		−0.030		0.165		−0.130
		(0.131)		(0.115)		(0.127)
4-5 hours		0.152		−0.172		0.101
		(0.308)		(0.250)		(0.301)
5-6-hours		0.113		0.878		0.475***
		(0.302)		(0.860)		(0.169)
More than 6 hours		0.135		1.650***		0.528*
		(0.295)		(0.518)		(0.275)

Note: Parentheses in the table indicate heteroskedasticity-robust standard errors.
***Statistically significant at a 1% level; **statistically significant at a 5% level; *statistically significant at a 10% level.
Source: Authors' calculations from the Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

effect would dramatically increase by excessive exposure to TV. However, the coefficients for video games were not statistically significant across all hours.

One may be concerned that the aggregated BPI includes some subcomponents that are more relevant to children's physical development than to their emotional well-being, such as Item 15 ("concerns about the level of sickness"), Item 16 ("worsening eyesight"), and Item 17 ("tendency to become sick"). We recalculated our estimates for BPI excluding these three items as a robustness check and confirmed that the results were not significantly different from

those shown in Table 2. Another concern is one of the subcomponents of the aggregated BPI, Item 11 ("bullies or is bullied"), which seems to include two opposite problem behaviors. Thus, we ran a separate regression for BPI excluding this item and conducted a robustness check, leading us to conclude that this item did not affect the overall result. These results will be provided on request. Conversely, some subcomponents of BPI may be very informative for understanding why TV and video games are harmful for children's behavioral problems. We ran separate regressions with only Item 7 ("lack of physical exercise") and Item 9 ("doesn't/can't play with friends") as dependent variables. The results showed that both TV and video games affected children's sedentary lifestyle but not their social nature. These results will also be provided on request.

The data contained a substantial number of twin or triplet pairs (345 complete pairs). Thus, we restricted the analysis to samples of twins or triplets to test the robustness of the above results. The advantage of using a sample of twins or triplets is that it enabled to more rigorously control for genetic endowments and family environments. However, twin-fixed-effect estimates may have a downward bias for the following reasons. First, because information on whether twins or triplets were monozygotic or dizygotic was not available, we could not perfectly control for genetic differences between twins. Second, if twins share the same space and only one of them is actively watching TV or playing video games, the other may not concentrate on his/her play. Schmidt et al. (2008) reported that background TV significantly disrupted young children's play behavior, leading to our estimate being biased downward. Third, young children of the same age will often be engaged in the same activities, that is, to increase the longevity of the good performance of the within-twin estimate of the effect of TV and video games, within-twin variation in hours of TV watched or video games played would need to be substantial. According to our calculations from the survey, only approximately 8% of twin pairs spent different hours (e.g., one of the twins watched TV much longer than the other twin, etc.). Therefore, twin-fixed-effect estimates are likely to be less precise than the fixed-effect estimates. As shown in Table 6, the twin-fixed-effects model also shows that the effects of TV and video games are indistinguishable from zero.

TABLE 6
Twin-Fixed Effects

	BPI	OS	BMI
TV	0.043**	−0.030	0.124
	(0.021)	(0.019)	(0.437)
Video games	0.056**	0.087	−0.130
	(0.019)	(0.170)	(0.389)
Gender	0.210**	0.126	0.062
	(0.091)	(0.078)	(0.182)
Constant	1.947***	−3.928***	14.999***
	(0.398)	(0.375)	(0.815)
Number of observations	685	678	630
(Number of pairs)	(345)	(344)	(317)

Note: Parentheses in the table indicate heteroskedasticity-robust standard errors.

***Statistically significant at a 1% level; **statistically significant at a 5% level; *statistically significant at a 10% level.

Source: Authors' calculations from the Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

The crucial underlying assumption in this model is that unobserved factors are constant over time. If there are time-variant unobservables, our result may be difficult to interpret in a causal way. The absence of random assignments or external variations of watching TV or playing video games makes it difficult to conduct flawless causal analysis. Unfortunately, there may not be any valid instruments in our dataset that would be expected to correlate with the hours of TV watched or video games played but not with children's development. However, it may be plausibly assumed that we can restrict our estimates. Our results clearly suggest that the fixed-effects estimates are much smaller than OLS estimates. This drop in the magnitude is consistent with the idea that parents and children who are more able—as captured by a higher unobserved heterogeneity—are less likely to watch TV and play video games. It is unlikely to be the case that time-varying unobservables, if they exist, would work in the opposite direction; therefore, our estimates must be considered as the upper bounds.

We need to examine the possibility of reverse causality: for example, if children who exhibit bad behaviors and attitudes at home or at school spend more time watching TV or playing video games, then we should expect a larger estimate for watching TV or playing video games. To verify this point, we estimated the effects from the lead hours of TV or video games on children's development and the effect from

TABLE 7
Reverse Causality

	BPI		OS		BMI	
	$t-1$	$t+1$	$t-1$	$t+1$	$t-1$	$t+1$
TV	0.022**	−0.020	0.021**	0.036	−0.002	0.033
	(0.009)	(0.024)	(0.007)	(0.023)	(0.019)	(0.022)
Video games	0.014	−0.035	0.018	0.012	0.039*	0.033
	(0.022)	(0.028)	(0.021)	(0.027)	(0.021)	(0.028)
	BPI		**OS**		**BMI**	
	$t-1$	$t+1$	$t-1$	$t+1$	$t-1$	$t+1$
TV	0.016	−0.025	0.006***	−0.011	0.052**	−0.000
	(0.018)	(0.022)	(0.001)	(0.020)	(0.019)	(0.021)
Video games	0.056**	0.037	0.008	−0.025	0.020	−0.023
	(0.022)	(0.028)	(0.022)	(0.024)	(0.023)	(0.026)

Note: Parentheses in the table indicate heteroskedasticity-robust standard errors.

***Statistically significant at a 1% level; **statistically significant at a 5% level; * at a 10% level.

Source: Authors' calculations from the Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

the lagged hours of TV or video games on children's outcomes, following Ward (2011). Reverse causality would imply that children's behavior or health problems in current period affects the hours of TV watched or video games played in later periods, whereas our hypothesized causality would imply that TV or video games in current period affects children's behavior or health. In other words, the effect from the lead hours of TV or video game on children's outcomes may capture the reverse causality. Table 7 showed that the effect of lead outcome variables was statistically insignificant, whereas the lagged TV or video game variables had significant negative effects on outcomes. These findings confirm that there is not a reverse causality between hours of TV watched or video games played and children's development outcomes. All things considered, we can interpret the coefficients presented in this section as the upper limit of the effect of TV or video games on children's development. In other words, if these biases were corrected, the magnitude of the negative effect would be smaller. Therefore, we can still confirm that the negative effect is sufficiently small to be considered negligible. Consequently, we can conclude from these empirical results that, while often negative in direction, more TV watching and video game playing are never significantly detrimental to children's problem behavior.

TABLE 8
Summary (Fixed-Effect Estimates)

	BPI		OS		BMI	
	Boys	Girls	Boys	Girls	Boys	Girls
TV	0.064***	0.055***	0.018	0.044**	0.053***	0.030**
	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)	(0.014)
Video games	0.037**	−0.005	0.052**	0.048**	−0.019	−0.016
	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)	(0.017)

Note: Parentheses in the table indicate heteroskedasticity-robust standard errors.

***Statistically significant at a 1% level; **statistically significant at a 5% level; *statistically significant at a 10% level.

Source: Authors' calculations from the Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

B. Orientation to School

We proceeded to investigate the effect of TV or video games on the second outcome of interest, OS. According to the OLS results demonstrated in the first and third columns of Table 3, the hours of TV watched and video games played were correlated with OS, holding other factors constant. The results are not varying by gender. The magnitude of the effect is that one additional hour of TV watched increased BPI by approximately 2–4% of its standard deviation and one additional hour of video games played increased it by approximately 10% of its standard deviation. Living with grandparents and having breakfast were also correlated with OS scores for boys, whereas having siblings was correlated for both boys and girls. However, the standardized coefficients suggest that the effects of TV and video games were slightly larger than that of other factors.

The second and fourth columns of Table 3 provide estimates from the fixed-effects model. The effect of hours of video games played was statistically significant for both boys and girls, but contrary to the result of OLS, that of hours of TV watched was statistically insignificant for boys. The statistical significance was not almost different between OLS and fixed-effects models, but the magnitude of video game variables was approximately one-third lower than OLS estimates. The magnitude of the effect is that one additional hour of TV watched increased BPI by approximately 3% of its standard deviation and one additional hour of video games played increased it by approximately 4% of its standard deviation. In addition to TV and video games, having breakfast, particularly for girls, and time spent alone at home were important determinants of how socially integrated children

were. Although we ran a random-effects model, according to the Hausman specification test, the model of choice was the fixed-effects model.

We also examined the nonlinearity of the effects of TV and video games on OS scores. The results are shown in Table 5 with fixed-effects estimates: the quadratic terms for TV and video games were not statistically significant. However, the dummy variables for some categories of TV and video games were statistically significant, indicating that there is a nonlinear effect of TV and video games on children's integration to school. In Table 6, the twin-fixed-effects model, with 345 complete pairs of twins or triplets, reveals no effect of TV and video games on the OS score. Moreover, there is no consistent evidence of reverse causality (Table 7). Consequently, regardless of the estimate used, the magnitude of the effect was sufficiently small to conclude that neither TV nor video games were detrimental to OS.

C. Obesity

We first estimated the OLS to measure the effect of hours of TV watched or video games played on childhood obesity, without considering time-variant unobserved heterogeneity across children. The first and third columns of Table 4 show that both TV viewing and video game playing were correlated with childhood obesity. The coefficient for TV indicates that one additional hour of TV watched was associated with a 0.243 increase for boys and a 0.223 increase for girls in BMI, which are approximately 10% of its standard deviation. One additional hour of video game played was associated with a 0.104 increase for boys and a 0.162 increase for girls in BMI, which are approximately 5% of its standard deviation. Consistent with previous literature, such as Sekine et al. (2002), we also confirm that the hours of sleep per day was associated with obesity, but on observing the standardized coefficients, the effects of TV and video games were much larger than that of other factors.

The second and fourth columns of Table 4 show the results from fixed-effects models. The magnitude of the hours of TV watched dropped to 0.053 for boys and 0.030 for girls, which represents approximately one-fifth and one-seventh of the estimate from OLS, respectively, which are approximately 1–2% of its standard deviation. For boys, lifestyle habits may play a crucial role in reducing obesity. In addition, we ran the random-effects models; however, according to the Hausman specification test, the model of choice was the fixed-effects model.

We also examined the nonlinearity of the effects of TV and video games on obesity. The results are shown in Table 5 with fixed-effects estimates. The quadratic terms for TV and video games were not statistically significant, but the dummy variables for the categories of TV watching clearly suggest a nonlinear relationship. In Table 6, the twin-fixed-effects model, with 317 complete pairs of twins or triplets, shows no effect of TV or video games on obesity. Moreover, there was no consistent evidence of reverse causality (Table 7). Consequently, regardless of the estimate, TV had a small effect on obesity, but video games had no effect.

D. Robustness Tests

We checked the robustness of our estimates in the following ways. First, we ran factor analyses to extract principal component factors for BPI and OS and replicated the same analysis with the same set of independent and control variables. The results were indistinguishable from the analysis using the complete BPI or OS. Second, as mentioned earlier, the respondents to the study survey were primary caregivers of a child: 92.3% of the respondents were mothers; the rest were fathers, grandparents, and other guardians. One may question whether the observations regarding children differ significantly between mothers and other caregivers. We replicated the same analyses on a restricted sample of mothers, but the results were indistinguishable from the analysis using the entire sample. Both results will be provided on request.

VI. CONCLUSION

This paper asks a straightforward question: Do TV or video games harm children's development? While much of the previous literature has documented a negative relationship between TV and children's cognitive and noncognitive development, some studies have found significant evidence disagreeing with this conclusion after controlling for unobserved characteristics among children and families. This study took advantage of the nationally representative longitudinal dataset collected from 2008 through 2010 to rule out unobserved heterogeneity and to isolate the pure effects of watching TV or playing video games on children's problem behavior,

school orientation, and obesity. The empirical results concluded that the answer to this question is yes; while often negative in direction, more TV watching and video game playing are never significantly detrimental to children's problem behavior, school orientation, and obesity, after controlling for unobservables. More precisely, as shown in Tables 5–8, hours of TV watched is associated with problem behavior and obesity, whereas hours of video games played has an effect on OS for both boys and girls. However, the magnitude of these effects is sufficiently small to be considered negligible. Nevertheless, we should bear in mind that the negative effects might increase by an excessive exposure to TV or video games.

APPENDIX

TABLE A1
Items of Behavior Problem Index and Orientation to School

Behavior Problem Index (BPI)
1. Using harsh language
2. Does not keep promises/tells lies
3. Does not initiate conversation
4. Does not listen
5. Plays in dangerous areas
6. Delinquency
7. Lack of physical exercise
8. Incessantly asks for things they want
9. Does not/cannot play with friend
10. Often fights with other children
11. Bullies/is bullied
12. Does not want to go to school
13. Concerns about studies
14. Concerns regarding food (including balanced diet and likes/dislikes)
15. Concerns about level of sickness
16. Worsening eyesight
17. Tendency to become sick
18. Concerns related to sex
19. Other
Orientation to School (OS)
1. S/he looks forward to seeing friends at school.
2. S/he looks forward to school studies (including PE and music).
3. S/he looks forward to school lunches.
4. S/he looks forward to seeing teachers and trusts them.
5. S/he looks forward to school activities (such as field trips and field days)

Note: The item regarding TV or video games, "S/he spends many hours watching TV or playing video games," was excluded from BPI.

Source: Longitudinal Survey of Babies in the 21st Century, Ministry of Health, Labour and Welfare.

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