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Is it only a game? Video games and violence☆

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ABSTRACT

Popular media often links violent video games to real-life violence, although there is limited evidence to support this link. I analyze how adolescent boys' violent behavior is affected by the releases of new violent video games in the U.S. Variation in children's exposure to the releases comes from variation in video game release and interview dates and thus is plausibly exogenous. I find no evidence that child reported violence against other people increases after a new violent video game is released. Thus, policies that place restrictions on video game sales to minors are unlikely to reduce violence.

1. Introduction

A link between violence in video games and violent behavior in real life is a much debated topic. This debate generally intensifies after mass public shootings. Some members of the public have linked these violent acts to the shooters' interests in violent video games. For example, the National Rifle Association (NRA) CEO Wayne LaPierre blamed Adam Lanza's obsession with violent games for the tragedy at Sandy Hook Elementary School in Newtown, Connecticut (Beekman, 2012). However, other members of the public have challenged these claims, pointing out that a number of other factors, for example, mental health problems and/or easy access to guns, could have lead to this and other acts of violence (Ferguson, 2014). It is also noted that the sales of video games in the United States have been increasing since the 1990s, whereas violent crime rates have been decreasing during the same period (Carroll, 2012). In the light of these conflicting claims, President Obama called for more government funding for research on video games and violence (Molina, 2013).

Reflecting the general public's concern about the detrimental effects of violent video games, several U.S. states have attempted to impose regulations on violent video game sales to minors. In the U.S., the video game industry, represented by the Entertainment Software Association (ESA), is currently self-regulated by the Entertainment Software Review Board (ESRB), which rates all video games on the basis of their content. The ESRB ratings provide guidance on the age-appropriateness of video games. A video game that contains the elements of intense realistic violence is usually M-rated. M-rated games are not recommended for individuals younger than 17 years of age. In what follows, I refer to M-rated games as *violent* games. Retailers are expected to follow the ESRB guidelines and refuse to sell M-rated games to children, although they have no legal obligations to do so. All attempts by the states to introduce legal obligations for retailers were appealed by the ESA and eventually struck down by the courts as violating free-speech rights (Barnes, 2011). The lack of convincing

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evidence on the relationship between violent video games and real-life violence is also mentioned in the court decisions (Barnes, 2011).

From a theoretical perspective, it is not certain that violent video games necessarily contribute to real-life violence. There are three mechanisms how violent video games may impact real-life violence, which may work in different directions. First, playing violent video games may directly affect children's propensity for violence. According to the psychology literature, however, the direct effect may be either positive or negative (Bensley and van Eenwyk, 2001). Second, when children play violent video games, they forgo other activities.[1] These activities may promote violence to a larger extent than violent video game playing. Therefore, it matters what activities are substituted by video game playing. Third, children who are attracted to violent video games are a selected group of children; they may be more likely to engage in such violence-promoting activities as loitering and drinking, which get substituted by video game playing when a new video game comes out. Because of the interplay between the direct, substitution and selection effects, violent video games may, in fact, reduce real-life violence.

In this paper, I provide empirical evidence on the effects of violent video game releases on children's violent behavior. The measures of violent behavior are obtained from the Child Development Supplement (CDS) to the Panel Study of Income Dynamics (PSID). I examine the effect of violent video games on two types of violence – aggression against other people and destruction of things/property. Violence measures are obtained from children themselves and their parents. The main sample is restricted to boys aged 8–18 years, a subgroup of children who are most likely to play violent video games. Data on the release dates of violent video games have been collected specifically for this study from an online video game database *MobyGames*. In addition, video games sales data from the *VGChartz* database are used to identify the most popular violent video games, which are expected to increase children's video game hours to a sufficient extent so that changes in violence levels could be detected in the data.

Variation in children's exposure to new violent video games comes from the variation in the timing of video game releases and CDS interviews: there is yearly and monthly variation in new violent video game releases, and the CDS interview dates vary across children and waves. Both sources of variation are plausibly exogenous to children's violent behavior conditional on year and season effects and household characteristics. It is important to control for the season effects, because more video games are released in the fall. Household characteristics are included in the regressions to address the concern that some households may be more difficult to reach and thus interviewed later.

I first use the exposure to the releases of popular violent video games to predict 8–18 year old boys' daily video game hours in the six months before the survey.[2] I find that boys' weekday video game playing increases by 15–20 min per day (32–39% with respect to the mean) following a release of a popular violent video game, but not immediately after the release. Statistically significant effects are found four to five months after the release. These effects are more pronounced for older (12–18 year old) boys and regular video game players. There are no effects of violent video game releases on girls' video game hours.

I then regress child and parent reported violence on the predicted video game hours. On the one hand, I find no evidence that a release of a popular violent video game increases violence, as self-reported by children themselves. On the other hand, parent reported destructive behavior is found to increase following a release of a popular violent video game in some subsamples of children. Taken together, these results suggest that all three - direct, substitution, and selection - effects are important. An increase in parent reported destructive behavior following a release of violent video game shows that children may act aggressively after playing violent video games. The likelihood of violence against people, however, does not increase, which suggests that the substitution and selection effects outweigh the direct effect. The results are consistent with more violence-prone boys being attracted to violent video games and/or video games substituting for other violence related activities. The importance of the substitution effect is supported by the finding that children spend less time away from home after a popular violent video game is released.

The existing evidence on the relationship between violent video games and violence comes mainly from laboratory experiments, in which children are randomly chosen to play either a violent or non-violent video game for a short period of time. It is generally found that children who play a violent video game are more likely to prefer 'aggressive' toys and show aggression toward other children immediately after (Bensley and van Eenwyk, 2001). These results are consistent with my finding that parent reported destructive behavior increases after a release of a popular violent video game, as parents are able to observe children immediately after video game playing. One limitation of such experimental studies is that they only provide evidence on the immediate effects of exposure to violent video games. It is uncertain whether the effects found in these studies persist in the longer term. Moreover, the setting of laboratory experiments differs from that in which video games are generally played. In particular, it is not taken into account that violent video game playing may substitute for other violence-related activities and that violent video games may attract children most likely to engage in these violence-related activities (which reinforces the substitution effect).

There are only a few economics studies on the effects of video games on violence. All of them suggest that there is no relationship between video games and violence. Ward (2010) shows that, conditional on observed characteristics, there is no association between video game playing and involvement in fights among adolescents. Ward (2011) finds

[1] It is possible to play a video game and engage in another activity, but in practice it is difficult to multitask while playing video games.

[2] The six month period is chosen, because children are asked about their violent behavior in the past six months.

that an increase in the number of video game stores in a county leads to lower local crime and death rates. Similarly, Cunningham et al. (2016) find no evidence that crime rates increase when violent video game sales go up. None of these studies provide evidence of the effects of violent video games on children, who may be most vulnerable to violence in video games and are the target population of the policies imposing restrictions on video game sales.

This paper contributes to the larger literature on the effects of media on individual behavior. DellaVigna and La Ferrara (2015) provide an excellent review of this literature. Of particular relevance is the study by Dahl and DellaVigna (2009) on violent movies, who find that violent crime rates decrease on the days with larger violent movie audiences in movie theaters. This study is also related to the broader literature on the determinants of violence and crime. Examples of the studies in this literature include Corman and Mocan (2005) on economic conditions and sanctions, Evans and Owens (2007) on police enforcement, Heaton (2006) on religion, Rees and Schnepel (2009) and Card and Dahl (2011) on football games, and Heaton (2012) on liquor laws.

2. Conceptual framework

2.1. Violence production function

Physical or emotional violence is a result of violent thoughts, emotions, and physiological arousal (Anderson and Bushman, 2001). We can think of the combination of these factors as an ‘internal violence state’ v_i^* of a child i. When a child's internal violence state exceeds a threshold $\bar{v}_i$, violent thoughts and emotions are expressed as violent behavior. The threshold $\bar{v}_i$ varies across individuals and depends on an individual's personality, upbringing, and other factors. An individual's internal violence state depends on innate predisposition to violence, childhood environment, other past experiences, and situational variables (Anderson and Bushman, 2001). Situational variables describe what an individual is doing, where, when, and with whom. Exposure to violent video games is one such situational variable. Thus, a child's internal violence state can be expressed as the following a function:

$$v_i^* = f(vvg_i, A_i, X_i, \beta_i) + e_i, \quad (1)$$

where vvg_i measures the hours spent playing violent video games, and A_i is a vector of the hours spent on other activities. Of particular importance is the time spent with other children, the time spent away from home, and the time spent loitering, as these circumstances create favorable conditions for violence. Children are more likely to engage in violence in a group, in the absence of parental supervision, and when they have no other activities to occupy themselves with. Vector X_i includes the measures of the child's personality, environment, and any other factors that affect the child's state of violence, and e_i is an idiosyncratic error term. The coefficient vector, which may vary across children, is denoted by β_i.

Violent video games can affect violence in two ways.[3] First, violent video game playing may directly affect children's internal violence state. Several psychological theories predict that children will be more prone to violence after playing violent video games (Bensley and van Eenwyk, 2001). For example, the social learning theory states that children can learn to act aggressively by observing and imitating video game characters. According to the arousal theory, playing violent video games leads to real-life violence, only if an individual already has a tendency toward aggression or is angered while playing a video game. To the contrary, the catharsis and drive-reduction theories state that violent video games provide an outlet for aggressive thoughts and feelings for individuals and in turn decrease real-life violence (Bensley and van Eenwyk, 2001).

Second, violent video games may have an indirect effect on violence through the activities displaced (substituted) by video game playing. When children spend more time playing video games, they spend less time doing other activities, as there are only 24 h in any given day.[4] This substitution effect can be negative or positive depending on the impact of the substituted activities on violent behavior. Video game playing reduces children's time spent away from home, because it is usually a home-based activity. Additionally, video games occupy children who would otherwise have nothing to do in their spare time. Thus, the substituted activities may, actually, promote violence to a larger extent than violent video game playing.

Assuming a linear functional form of f for simplicity, the total effect of an increase in video game hours on violence equals:

$$\frac{\partial v_i^*}{\partial vvg_i} = \beta_{vvg,i} + \sum_{k=1}^{K} \beta_{ak,i}\lambda_{ak,i}, \quad (2)$$

where $\beta_{vvg,i}$ and $\beta_{ak,i}$ are the coefficients on video game hours and hours spent on another activity ak_i, respectively, $k = (1, \ldots, K)$. Parameters $\lambda_{ak,i}$ capture the substitution pattern between video game playing and other activities: when a child spends an additional hour per day playing video games their time spent on activity ak_i decreases by $\lambda_{ak,i}$[5]

[3] The discussion that follows draws on Dahl and DellaVigna (2009) and DellaVigna and La Ferrara (2015).

[4] An increase in video game hours may not necessarily decrease other activity hours, because children can multitask, that is, perform two or more activities at the same time. In this case, the indirect effect of video game playing encompasses the reduction of attention given to the multitasked activity. In practice, multitasking while playing video games is rare.

[5] The time spent on an activity can also increase when the time spent on video game playing increases, if this activity is complementary to video game playing.

2.2. Video game releases and violence

Policy makers can only restrict violent video game releases and sales, but not video game hours per se. As mentioned in the introduction, several U.S. states attempted to introduce such policies in the recent years. Therefore, from policy perspective we would like to know how children's access to violent video games affects their violent behavior. To answer this question, we would estimate the following regression model:

$$v_i^* = \sum_{m=1}^{M} \gamma_{m,i} r_{im} + X_i' \gamma_x + u_i, \tag{3}$$

Variables r_{im} $(m = 1, \ldots, M)$ indicate whether or not there was a new popular violent video game released m months ago. Parameters $\gamma_{m,i}$ measure how a child's violence state is affected m months after a release of a new violent video game. The thought experiment underlying this regression is a comparison of two worlds for children - one with access to violent games and another one with no access.

It is expected that when a new violent video game is released, children's violent video game playing increases on average, which in turn affects their internal violence state as per Eq. (1). Although violent (M-rated) video games are deemed inappropriate for children under 17 years, the data show that a majority of under-age video game players get access to M-rated games (Gentile et al., 2007) likely by getting their parents to buy these games for them. The increase in violent video game playing is expected to be larger after the releases of the most popular games. In Section 5.1, I show that children indeed play video games for longer hours for up to 5 months after a release of a popular violent video game.

It is important to note that selection into playing a new violent video game after its release is non-random. Violent video games are most popular among teenage boys, for example. Teenage boys are also more likely (than girls or younger boys) to engage in fighting and violence-promoting activities, such as drinking and loitering. When children play video games, however, they cannot engage in these activities, as discussed above. It is possible that these substituted activities increase violence to a larger extent than violent video games. Therefore, after a release of a violent video game real-life violence may, in fact, decrease.[6]

The substitution and selection effects can explain why studies based on experimental and real-life data can reach different conclusions about the effect of violent video games on real-life violence. Experimental studies recover the direct effect of violent video game playing on violence (β_{vvg}) for an average child, as the alternative activity, non-violent video game playing, is assumed to not affect violence. Thus, experimental evidence shows how children may be affected by unexpected exposure to violence in a video game, for example, if they are not aware that the video game contains violence. However, experimental studies fail to account for the substitution and selection effects.

In contrast, studies based on real-life data, including this study, can identify the total effect of video game playing, which includes not only the direct but also the substitution and selection effects. The total effect is a relevant parameter for the evaluation of policies that restrict children's access to violent video games. The effectiveness of these policies depends not only on whether violent video game playing increases violence but also on how activities displaced by violent video game playing are related to violence and who plays violent video games.

3. Identification and estimation

Although Eq. (3) produces policy-relevant parameters, its estimation is challenging in practice. It needs to include a large number of lags of violent video game releases to account for the complicated dynamic relationships between new video game releases, video game hours, and violence. First, some children buy a new game immediately after its release, but many wait for a few months until the price drops. Second, video game hours are likely to remain higher for several months after the release, as modern video games are challenging and complex enough to keep players interested for extended periods of time. Third, video game playing may have delayed and/or lasting effects on violent behavior. Fourth, the time spent on other violence-related activities, substituted by video game playing, may increase after children loose interest in the video game. Finally, violence is usually measured over the past several months in surveys, including the survey used for this analysis, in which children are asked about their violent behavior in the past six months, as detailed in Section 4.6.

Due to the empirical challenges in estimating Eq. (3), I follow a different estimation approach. In particular, I first regress children's video game hours in the past month on new popular violent video game releases in the past six months. Then, I use this regression to predict their average video game hours over the past six months. We need a measure of children's average video game hours over the past six months, because children's delinquency is measured over the same period. Video game hours are, however, only available in the past month for each child in the data. They are measured using time diaries, which were completed only once. The time diaries should measure children's activities over the past month quite accurately, but they would provide increasingly less accurate measures of the activities in the preceding months.

Finally, I regress children's violent behavior on their average predicted video game hours over the past six months. The estimates of this regression show how children's violent behavior changes when their average video game hours increase in response to new releases of popular violent video games. An approximate (reduced form) effect of new violent video

[6] Selection in this case is part of the causal effect of violent video games.

game releases on violent behavior, which is of interest to the policy makers, can also be recovered. The specific steps in this procedure are as follows:

1. Regress children's video game hours in the past month vvg_{i1} on indicators of new popular M-rated video game releases in the past one to six months r_{im} and the same control variables X_i as in Eq. (3):

$$vvg_{i1} = \sum_{m=1}^{6} \delta_m r_{im} + X_i' \alpha + v_i. \tag{4}$$

2. Use Eq. (4) to predict video game hours in the past one to six months: $\widehat{vvg}_{in} = \sum_{m=n}^{6+n-1} \hat{\delta}_m r_{im} + X_i' \hat{\alpha}$, $n = 1, \ldots, 6$.
3. Compute the average predicted video game hours over the past six months: $\overline{\widehat{vvg}_i} = \frac{\sum_{n=1}^{6} \widehat{vvg}_{in}}{6}$.
4. Regress an indicator of violent behavior v_i on the average predicted video game hours and the control variables:

$$v_i = \theta_{vvg} \overline{v\hat{v}g_i} + X_i^{'} \theta_x + \varepsilon_i. \tag{5}$$

5. To recover approximate reduced form effect of violent video game releases on violence m months after the release, multiply $\hat{\theta}_{vvg}$ by $\hat{\delta}_m$.

This method has a spirit of two-sample instrumental variable (IV), because all the necessary variables are not available in the main data set and a complementary data (on video game releases) is used to obtain predictions of these variables. The difference from two-sample IV model is that only one sample of children is used in the analysis.

The variation in children's exposure to new violent video games comes from the variation in new violent video game releases and interview dates. One possible threat to the internal validity is that many of the popular video games are released towards the end of the year; therefore, children interviewed in fall or winter are more likely to be exposed to new violent video games. There may also be seasonal variations in children's behavioral problems, as some studies suggest (Carskadon and Acebo, 1993; Kovalenko et al., 2000). To take these possibilities into account, I include season and year effects in all equations. In Section 4.3, I show that there is no systematic pattern left in violent video game releases once these variables are controlled for.

Another threat to internal validity relates to interview timing. Although the interviews in the survey used for the empirical analyses are not scheduled in a systematic way, some households may be more difficult to reach and thus interviewed later, which introduces the correlation between the exposure to new violent video game releases and household characteristics. The same household characteristics may be correlated with children's behavioral problems. To investigate whether there is a systematic variation in interview timing, I regress interview timing on a number of child and household characteristics. I also include the same set of child and household characteristics in all regressions.

The final concern relates to the correlation between violent and non-violent video game releases, because it is not possible to separate children's time spent playing violent and non-violent video games in the data. If there is correlation between violent and non-violent video game releases, the coefficients δ_m in Eq. (4) will capture both increase in violent and non-violent video game playing; in turn, the coefficient θ_{vvg} in Eq. (5) will measure the effect of both violent and non-violent video game hours. It is not certain whether this would lead to upward or downward bias in θ_{vvg}. On the one hand, no direct effect of non-violent video games on violence is expected, and the substitution effect is still present. On the other hand, the selection effect is expected to be weaker: children who are attracted to non-violent games, on average, should be less likely to engage in violence-related activities than children who are attracted to violent video games. To address these concerns, I check robustness of the results to controlling for non-violent video game releases. I also estimate the effects of non-violent video games on violent behavior.

4. Data and variables

4.1. Survey data

The main data source used for the empirical analyses is the Child Development Supplement to the Panel Study on Income Dynamics (CDS-PSID). The PSID is the longest running longitudinal survey of U.S. households, which began in 1968. In 1997, the CDS was added to the PSID because the core PSID survey only collects limited information on children. The main purpose of the CDS is to collect information on factors that affect children's health and human capital development. It also includes the measures of children's behavioral problems and delinquency. Additionally, extensive information is collected about children's home environment and parental characteristics.

Up to two children under 13 years of age were included in the CDS from each PSID household in 1997 (wave 1). Data on more than 3500 children were collected. These children were surveyed two more times - in 2002–2003 (wave 2) and 2007–2008 (wave 3). In 2014, a new sample of 4333 0–17 year old children from PSID families was selected and interviewed in 2014–15 (wave 4). Most information in the CDS is collected from the primary caregiver of the child, which is generally the mother. The primary caregiver completes a separate interview for each child in the household and answers questions about the household. Older children answer some additional questions themselves. The CDS-PSID has a time diary component, which I use to measure children's video game hours. The interviewers also measure children's height and weight and assess their cognitive skills using achievement tests.

Table 1
Descriptive statistics of the sample.

	2002 (1)	2007 (2)	2014 (3)	All (4)
White non-Hispanic	0.446	0.470	0.425	0.445
Black non-Hispanic	0.442	0.399	0.405	0.418
Hispanic	0.066	0.079	0.106	0.083
Other race	0.046	0.052	0.064	0.054
Age	13.192	14.533	12.553	13.334
HH equivalized annual income (‘000, 82–84$)	16.731	17.756	15.146	16.417
PCG education (years)	13.143	13.104	13.672	13.330
PCG non-employed	0.240	0.256	0.330	0.278
PCG age	41.245	42.039	40.693	41.254
Single parent HH	0.424	0.443	0.479	0.450
Number of children in HH	2.253	2.198	2.569	2.346
Central counties of metro areas pop ≥ 1 m	0.302	0.291	0.255	0.283
Fringe counties of metro areas pop ≥ 1 m	0.156	0.173	0.133	0.153
Counties in metro areas pop 250k-1 m	0.261	0.244	0.298	0.269
Counties in metro areas pop < 250k	0.048	0.044	0.073	0.056
Counties adjacent to metro area	0.094	0.087	0.101	0.094
Counties not adjacent to metro area	0.140	0.161	0.140	0.146
SRC sample	0.522	0.566	0.548	0.543
SEO sample	0.404	0.350	0.368	0.377
Migrant sample	0.073	0.084	0.085	0.080
HH information missing	0.204	0.109	0.029	0.119
Autumn	0.207	0.528	0.153	0.275
Winter	0.650	0.379	0.521	0.534
Spring/Summer	0.140	0.094	0.320	0.189
Popular M-rated VG released				
0–1 months ago	0.630	0.673	0.559	0.617
1–2 months ago	0.638	0.698	0.570	0.631
2–3 months ago	0.835	0.666	0.609	0.714
3–4 months ago	0.820	0.615	0.495	0.655
4–5 months ago	0.641	0.638	0.465	0.581
5–6 months ago	0.476	0.427	0.495	0.469
Weekday daily video game hours	0.721	0.732	0.816	0.741
Weekend daily video game hours	1.343	1.507	1.971	1.504
Aggression against others (child-reported)	0.215	0.207	0.078	0.182
Aggression against others (parent-reported)	0.194	0.133	0.126	0.155
Destructive behavior (child-reported)	0.148	0.136	0.072	0.127
Destructive behavior (parent-reported)	0.097	0.083	0.131	0.105
Sample size	1227	832	1052	3111

Notes: The sample consists of 8–18 year old boys. In Panel A, exposure to popular (10 best selling) video games is measured with respect to the PCG Interview date. HH stands for household, PCG for primary caregiver, SRC for Survey Research Center, and SEO for Survey of Economic Opportunity.

In the empirical analyses, I use waves 2–4, because violence in the games released in 1990s was animated and non-realistic, which explains why relatively few video games were classified as M-rated. New advancements in video game graphics since then have allowed creating games that are much more realistic. Additionally, the quality of the data on video game sales and release dates in 1990s is poor. I focus on the subpopulation of children who are most likely to play violent video games, 8–18 year old boys. Gentile et al. (2007) report that close to 70% of children aged 8–17 years play violent (M-rated) video games. Olson et al. (2007) find that among video game players aged 12–14 years, close to 70% of boys played at least one M-rated video game in the past six months compared to 30% of girls.

There are 3111 child-year observations on 2556 boys between 8 and 18 years of age in the analysis sample. Given the age restrictions and no overlap between the 1997 and 2014 CDS samples, most of the sample boys (78%) are observed once. To account for the presence of siblings and repeated observations in the sample, standard errors are clustered at the 1968 household level in all estimations. Table 1 presents the means of child and household characteristics in the analysis sample. PSID oversamples lower income households[7], which explains lower means of socioeconomic variables in the analysis sample comparing to the U.S. population. Less than half of the sample boys are white, 42% are Black, and 8% are Hispanic. Primary caregivers on average have 13.3 years of education, and more than a quarter of them are non-employed. Almost half of the children live with only one of the biological parents. Children and primary caregivers are on average 13 and 41 years old, respectively. Most children live in relatively large metropolitan areas. Household information (household income, primary caregiver employment, education, age and single parent status) is missing for a number of the observations, especially in 2002. To increase sample size, an indicator for missing household information is created and included in all

[7] Almost 40% of the analysis sample are from the lower income Survey of Economic Opportunity (SEO) sample.

Table 2
Lifetime sales[a] of top 10 video games released in the U.S. in analysis years.

Release year	Sales, m				Overall rank
	Mean (1)	S.D. (2)	Min (3)	Max (4)	Mean (5)
A. M-rated					
2001–03	2.06	1.87	0.53	8.41	39
2006–08	3.23	2.80	0.65	11.34	31
2013–15	4.45	4.82	1.10	23.06	12
B. T-rated					
2001–03	2.75	1.15	1.17	6.25	17
2006–08	3.44	1.99	1.54	11.07	18
2013–15	1.27	0.96	0.36	4.95	33
C. E-rated					
2001–03	3.64	1.46	1.79	6.85	11
2006–08	6.84	7.33	2.10	41.28	10
2013–15	3.21	1.55	1.10	6.01	12

Sources: VGChartz, MobyGames.
[a] As of August 2016.

regressions. Table 1 shows that there is variation in interview timing across both households and waves. In 2002 and 2014, most households were interviewed in winter, whereas in 2007 most interviews were completed in autumn.

4.2. Video game sales

To construct measures of children's exposure to new popular violent (M-rated) and non-violent (E- or T-rated) video games, I supplement the CDS data with the data on video game sales, ratings, and release dates. To identify the most popular video games, I use the data on video game sales from the *VGChartz* database (http://www.vgchartz.com/gamedb/). *VGChartz* provide the estimated sales of a large number of games by region free of charge.[8] *VGChartz* commenced operations in 2005, but video game data have been also collected retrospectively starting 1994. To obtain the sales estimates, *VGChartz* use data from a representative sample of small retailers combined with statistical prediction methods (VGChartz, 2016; Walton, 2007). *VGChartz* claim that their data are within 15% accuracy in a given week (Walton, 2007).

To rank video games, I use lifetime sales of each game (as of August 2016) in the United States across all gaming platforms. An alternative way is to use the sales in the year of the release, but *VGChartz* provide annual sales data starting 2005 only. Using the lifetime sales to measure the popularity of games would only be an issue if some games only became popular several years after the release. The investigation of sales patterns reveals, however, that the largest share of sales of popular violent games take place in the year of release or the following year. The sales of popular non-violent video games are more spread out and sales remain high for a number of years. These differences across rating categories do not create difficulties for the analysis, because the popular games are selected based on sales ranking within each rating category. Online Data Appendix B.1 discusses the descriptive statistics of *VGChartz* data.

4.3. Video game ratings and release dates

I merge *VGChartz* video game sales data with the data on the ratings and release dates of video games obtained from *MobyGames* (http://www.mobygames.com/), a free online database, which contains video game ratings and release dates. The data from both *VGChartz* and *MobyGames* are obtained using web scraping in *MsExcel*. The two databases are merged using the video game name, but due to the differences in the names of games across the two databases, many of the ratings and release dates needed to be entered manually. I have cross-checked video game ratings with the ESRB website (https://www.esrb.org/ratings/search.aspx), and found no disagreements. Release dates have been cross-checked with *IMDb* database (http://www.imdb.com/). There are a few disagreements between *MobyGames* and *IMDb* databases about the release dates of older games (released in 2001–2003), but they are small (in the order of a few days). In case of a disagreement, I have consulted the other two databases *IGN* (http://www.ign.com/) and *GameSpot* (http://www.gamespot.com/) and selected the date agreed upon by the majority of the sources. *MobyGames* provides information on both the date a game was first released in the United States, and the dates of its later releases on other video game playing devices. I take into account only the first-time releases, because the bulk of video games sales take place after the first release.

Within each rating category and year, popular video games are defined as the ten best selling games released in that year. The main focus of this analysis is on M-rated video games, which usually contain elements of violence, and therefore

[8] The sales data are missing for some games. Cross-checking with another video game database *IMBd* suggests that the sales data are missing for the less popular games, as measured by video game ratings and the number of video game players rating a game. For example, many of the games with missing sales data are the special editions of original games.

are targeted by policy makers and interest groups. I refer to these games as violent. Some regressions also include measures of exposure to new releases of T and E or E10+[9] rated video games. T-rated games may contain elements of violence, but to a lesser extent than M-rated games; they are intended for children older than 12 years. E-rated games are generally non-violent and can be played by younger children.[10] An exploration of the content descriptors for the 10 best selling M-, T-, and E-rated video games in 2007, provided in Online Data Appendix B.2, reveals that most of the M-rated games contain “violence” (4/10) or “intense violence” (5/10), “blood” (2/10) or “blood and gore” (7/10), and “strong language” (5/10). “Intense violence”, “blood and gore”, and “strong language” differentiate the M-rated games from the T-rated games. None of the T-rated games contain these elements, although many T-rated games contain “violence” (7/10), “animated blood” (2/10) or “blood” (4/10) and “mild language” (2/10) or “language” (3/10). Even E-rated games have elements of violence (5/10), but it is mild animated or cartoon violence. Thus, it is not violence per se that differentiates M-rated games from the other games, but intense, realistic, and gruesome violence.

I also categorize all best selling M-rated video games by how realistic violence in these games is. ESRB does not indicate whether violence is realistic for all games, so I use my own (arguably arbitrary) judgement based on the description of the games provided by *MobyGames*. Around 40% of the best selling M-rated video games contain real-life violence. The examples of such games are Call of Duty, Grand Theft Auto, and Battlefield series, which are set in the real world and current times. The remaining games are set in fictional, fantasy, historic, or futuristic worlds; the examples of these are Mortal Kombat, Assassin’s Creed, Elder Scrolls, and Fallout.

Table 2 presents the mean, minimum, and maximum sales of the best selling E-rated, T-rated and M-rated games released in 2001–03, 2006–08, and 2013–15 (the years relevant for the empirical analysis). Panel A of Table 2 shows that M-rated video games have become popular (relative to T-rated and E-rated games) only quite recently, likely owing to the appearance of new modern M-rated games enabled by the advancements in video game technology. Mean sales of the top 10 M-rated video games increased from close to 2 million copies in 2001–03 to almost 4.5 million copies in 2013–15. Minimum and maximum sales of popular M-rated video games also are higher in the recent years. Grand Theft Auto V, released in 2013, reached the record sales of 23 million copies (by August 2016). To the contrary, the sales of T- and E-rated video games have been decreasing in the recent years.[11] Mean overall ranking of E-rated, T-rated and M-rated video games[12], presented in column (5) of Table 2, shows the same pattern. In 2001–03 and 2006–08, the mean ranking of the top-10 M-rated games among all games released in the given year was quite low (39 and 31, respectively), whereas in 2013–15 the most popular M-rated games were ranked 12 on average. The trend is reversed for the T-rated games. Their mean overall ranking decreased from 17 in 2001–03 to 33 in 2013–15.[13] The changes in the popularity of M-rated video games are analyzed in more detail in Online Data Appendix B.3, which lists the top 3 best selling video games released from 2001 to 2015.

Online Data Appendix B.4 lists all 10 best selling M-rated games every year during the analysis period along with their release dates, life-time sales, and indicator whether the game contains real-life violence or not. Popular M-rated video games are released throughout the year, but more than 50% are released in Autumn, mainly in November (30%) and October (20%). To account for the seasonality in video game releases, all regressions control for the season effects. Fig. 1 shows that there is no systematic pattern in M-rated video game releases, conditional on season and year effects. To construct this figure, I regress a binary variable, which indicates that there is a new top-10 violent video game released in a given month, on the season and year effects and plot the residuals of this regression. To facilitate exposition, the residuals in years 2001–03, 2006–08, and 2013–15 are presented in separate panels (A, B, and C, respectively), but all three graphs are based on the same regression. The months relevant for this analysis are plotted in black, whereas the remaining months are plotted in grey. Fig. 1 demonstrates that there, indeed, is no systematic pattern in new popular violent video game releases once season and year effects are controlled for. Unusually high and low probabilities of popular violent video game releases are observed in different months across the years.

4.4. Exposure to video game releases

Children’s exposure to new popular M-rated video games is measured by a set of indicator variables that take the value one if a new popular M-rated video game has been released m months ($m = 1, \ldots, 12$) before the date of the relevant PSID questionnaire (weekday or weekend time diary, primary caregiver (PCG) questionnaire, or child questionnaire). Within a given wave, the variation in the exposure comes from variation in interview dates. As mentioned above, there is no systematic allocation of the interview dates in the CDS-PSID, and therefore, children’s exposure to new popular video games is assumed to be plausibly random.

[9] In the remainder of the paper, E-rated games refer to both E and E10+ rated games.

[10] I do not analyze exposure to eC-rated games intended for young children or AO-rated games intended for adults, as they are not targeted at young boys who are the focus of my analysis.

[11] However, it is too soon to conclude that E-rated games are becoming less popular given that their sales remain high for several years after the first release.

[12] Mean overall ranking for each category of games is obtained by ranking *all* games released in a given year according to their lifetime sales, selecting 10 best selling games in each category, and averaging their ranking.

[13] Increasing popularity of M-rated games is one possible explanation for decreasing popularity of T-rated games. ESRB has also changed the rating category of several games (for example, Batman and Elder Scrolls) from T to M over time, because violence in the newer releases of these games became more realistic and intense.

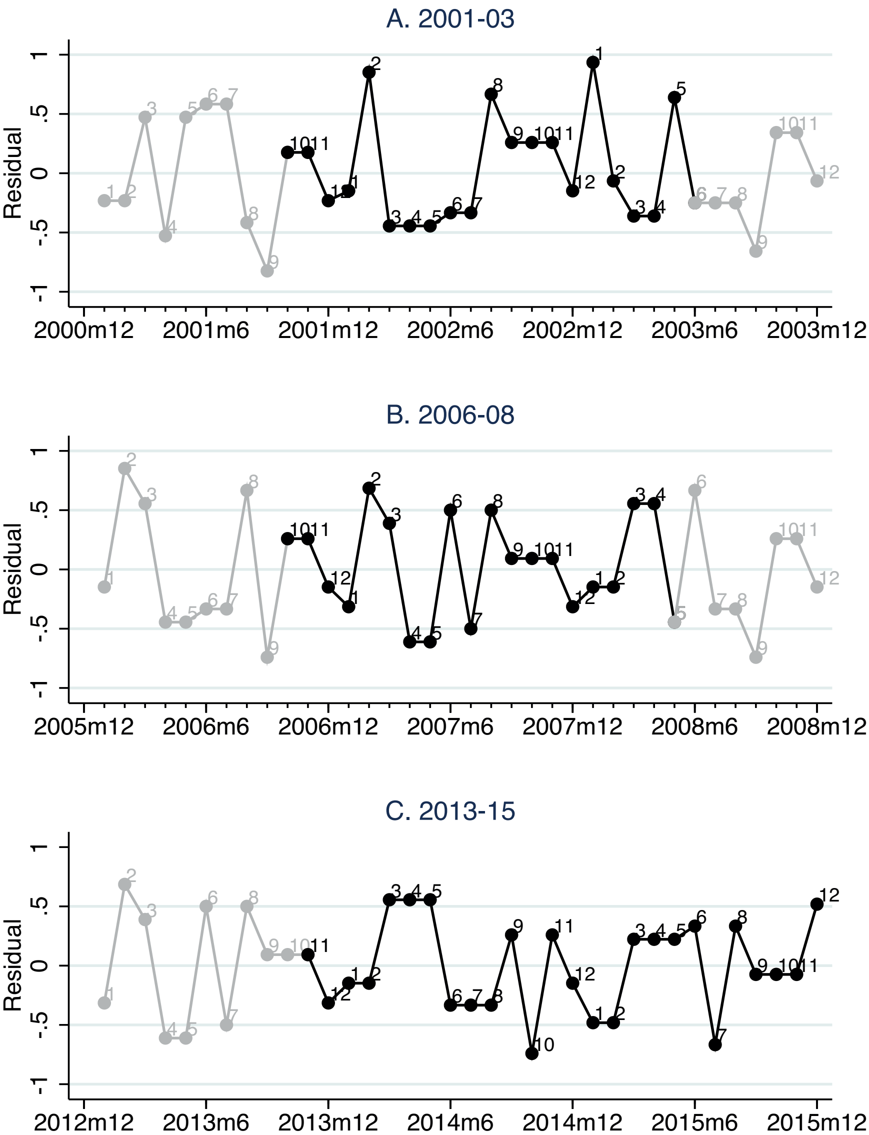

Fig. 1. Variation in new top 10 violent video game releases by month, 2001–2015. *Notes*: The figure depicts the residuals of an OLS regression of releases of top 10 (best-selling) M-rated video games. In this regression, the dependent variable takes the value 1 if there is a new top 10 M-rated video game released in a given month and the value 0 otherwise. The regression controls for year and season effects. All graphs (A, B, and C) are based on the same regression. The time periods covered in the empirical analysis are depicted in black color.

One threat to this assumption is the variation in household willingness to be interviewed. Some households may be more difficult to get hold of and thus interviewed later. To check this, I regress the dates of the four components of the CDS-PSID survey (weekday or weekend time diary, PCG questionnaire, and child questionnaire) on the following child and household characteristics: the child's race and age; the primary caregiver's education, employment status, and age; the family's structure (indicator for single biological-parent households and the number of children in the household) and equivalized real income (in 1984 dollars); rural-urban status of the county; and the PSID sample the household comes from (nationally representative Survey Research Center [CRS], lower income Survey of Economic Opportunity [SEO], or the migrant refresher sample). All regressions control for season and year effects. For each survey component, the date is normalized with respect to the date of the first completed interview/time diary in that wave.

Table 3 shows that most of the child, PCG, and household characteristics are not significantly correlated the date on which the questionnaire was completed. The only consistently significant findings are that households with employed PCGs, higher income, and located in remote counties are interviewed later. Hispanic and older children also tend to complete some of the questionnaires later. These differences can be explained by the variation in the availability and accessability of households. To account for this, I include the child and household characteristics from Table 3 in all regressions. These

Table 3
Correlation between household characteristics and survey timing.

	Time diary		PCG	Child
	Weekday (1)	Weekend (2)	interview (3)	interview (4)
Black non-Hispanic	−1.282	−1.614	1.258	−2.332
	(4.920)	(4.924)	(1.750)	(2.642)
Hispanic	10.475	9.593	9.259***	9.276**
	(8.068)	(7.899)	(2.239)	(3.688)
Other race	3.988	5.452	−0.518	0.579
	(6.884)	(6.859)	(2.296)	(4.208)
Age	0.792*	0.641	0.611***	0.946***
	(0.421)	(0.413)	(0.151)	(0.302)
HH equivalized annual income (‘000, 82–84$)	0.059*	0.050*	0.049***	0.076***
	(0.030)	(0.029)	(0.016)	(0.022)
PCG education (years)	0.126	−0.083	−0.072	−0.458
	(0.613)	(0.582)	(0.227)	(0.320)
PCG non-employed	−7.292***	−7.034***	0.454	−2.838*
	(2.444)	(2.413)	(1.087)	(1.467)
Single biological-parent HH	5.707*	3.728	0.824	0.996
	(2.925)	(2.844)	(1.034)	(1.401)
Number of children in HH	−0.317	−0.527	0.125	0.785
	(1.144)	(1.113)	(0.431)	(0.601)
PCG age	0.219	0.262	0.021	0.004
	(0.227)	(0.225)	(0.065)	(0.105)
SEO sample	6.385	7.475	−0.915	1.891
	(5.094)	(5.095)	(1.740)	(2.599)
Migrant sample	13.116*	8.966	2.103	0.711
	(7.881)	(7.535)	(2.238)	(3.847)
Fringe counties of metro areas pop $\geq$ 1 m	−0.784	−1.269	−1.777	−2.317
	(3.618)	(3.609)	(1.492)	(1.923)
Counties in metro areas pop 250k-1 m	6.890**	6.353**	0.539	−0.390
	(3.143)	(3.203)	(1.227)	(1.628)
Counties in metro areas pop $<$ 250k	−4.336	−3.301	−3.152	−1.749
	(3.558)	(3.477)	(2.019)	(3.056)
Counties adjacent to metro area	6.051*	5.105	−0.530	−4.229*
	(3.520)	(3.479)	(1.792)	(2.467)
Counties not adjacent to metro area	8.492***	6.197**	3.258**	3.900*
	(3.203)	(2.999)	(1.456)	(2.044)
Mean(dep var)	83.140	83.404	81.932	80.963
Sample size	2056	2035	3111	1586

Notes: For each survey component, the date is normalized with respect to the first interview/time diary date in that wave and is measured in days. In columns (1)–(3), the sample consists of 8–18 year old boys. In column (4), the sample consists of 12–18 year old boys. Standard errors (clustered at the 1968 household level) are presented in parentheses. All regressions also control for missing household information dummy, season, and year effects. Omitted categories are white, SRC sample, and central counties of metropolitan areas of 1 million population or more. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

characteristics are plausibly exogenous to (not affected by) child violent behavior and video game playing and thus are valid controls.

Table 2 shows what proportion of the sample in each wave are exposed to a new popular M-rated video games one to six months before the PCG interview date. The proportion of 8–18 year old boys exposed to new M-rated video games varies across years and months from 42.7% to 83.5%, but in most months, 50–60% of the boys in the analysis sample have a new popular M-rated video game released. The exposure to new popular M-rated games is somewhat lower in 2014 than 2002 and 2007, reflecting the differences in the interview timing from 2014. A substantial proportion of the analysis sample are exposed to new popular popular E-rated games (36.3% to 80.5%) and somewhat smaller to new popular T-rated games (27.4% to 77.5%) (not reported). Importantly, the exposure in a given month before the PCG interview varies across the three types of video games, reflecting different timing of M-rated, T-rated, and E-rated video game releases.

4.5. Video game hours

Children’s video game hours come from the time diaries. All children are sent two 24 h time diaries, which they are asked to complete before the interview.[14] One diary needs to be completed on a randomly assigned weekday and another one on a randomly assigned weekend day. Children list all activities they perform on the specified day and detail when each activity started and ended as well as who else was participating in the activity and where the activity took place. The

[14] Despite the instructions, almost half of the diaries were completed after the interview.

time diaries are then reviewed by the interviewer and coded by the PSID staff. Importantly, the activity codes are detailed enough to separate video game playing from other media activities or other games, although it is not possible to further separate video game playing into violent and non-violent. Time diary data is available for the 70% of the analysis sample (2,156 child-year observations).[15]

Close to 66% of 8–18 year old boys report playing a positive number of video game hours on either weekday or weekend day. This is likely to be an under-estimate of the prevalence of video game playing, because 87% of boys self-report that they play video games at least once a week. Table 2 shows that, on average, boys spend longer time playing video games on weekends (1.5 h per day) than on weekdays (0.74 h per day). On the other hand, there is more variation in weekday video game hours: the coefficient of variation equals 1.9 and 1.5 on weekdays and weekends, respectively. Average weekday daily hours increased from 0.7 in 2002 to 0.82 in 2014, and average weekend daily hours increased from 1.3 to 1.97 during the same time. Among video game players, the average number of daily hours is 1.8 and 2.7 on weekdays and weekends, respectively. Regressions of children's video game hours on child, PCG and family characteristics show that daily weekday and weekend video game hours increase with a child's age and decrease with the mother's education. Children in more urban areas play video games for longer time. Conditional on these characteristics, there are no statistically significant differences in video game hours by household income, mother's employment or age, or family structure.[16]

Although children were supposed to complete both time diaries in the same week, often there is a substantial gap between weekday and weekend time diary completion. Since the timing of the time diary completion is important for the precise measurement of the exposure to new video games, I do not aggregate weekday and weekend hours. Instead, I use weekday video game hours in the main empirical analyses, and check robustness of the results to the use of weekend video game hours.

4.6. Child and parent reported violence

In the confidential computer/phone-assisted part of the CDS Child Interview, children aged 12 years or older are asked how many times in the past six months they engaged in a list of delinquent behaviors.[17] As measures of child reported violence, I use two of these questions: (1) "In the last 6 months, about how many times have you hurt someone badly enough that he/she needed bandages or a doctor?" and (2) "In the last 6 months, about how many times have you damaged school property on purpose?" The first question is the closest measure of violence as it is usually defined. In the remainder of the paper, I refer to the first measure as *aggression against others* and the second one as *destructive behavior*. Since the frequency of delinquent behaviors in the past six months are likely to be reported with error, I create binary variables, which measure the incidence of these behaviors in the past six months. Table 2 shows that 18.2% of boys report seriously hurting someone and 12.7% report damaging school property in the past six months. There is a sharp decline in child reported violence across CDS waves: the incidence of both types of violence in 2014 is 40–50% lower than in 2002 or 2007. It could reflect an actual decrease in violence, but it could also be due to reporting differences across waves. In 2014, answers to confidential questions were collected via the cell phone, whereas previously it was done via the computer, which could explain the differences in responses, especially that similar trend is not observed in parent reported violence, as shown below.[18] To account for these changes, all regressions control for wave effects. I also estimate violence regressions separately for year 2014.

In the CDS PCG Interview, the adult who has the primary responsibility for a child is asked about the child's behavioral problems. These questions are used to construct the "Behavior Problems Index" (BPI) (Peterson and Zill, 1986), which is commonly used in the literature to measure children's 'non-cognitive' skills. Two behavioral problems related to violence are (1) "He bullies or is cruel or mean to others" and (2) "He breaks things on purpose or deliberately destroys things." The first question is most related to the traditional definition of violence. In parallel to the child-reported violence measures, I refer to the first question as aggression against others and the second one as destructive behavior. The primary caregiver of a child is asked how often these statements are true for the child, and possible answers are "Not true," "Sometimes true," or "Often true." To minimize the measurement error, I aggregate the latter two categories, as parents may be more comfortable admitting that their children behave badly sometimes rather than often. Panel B of Table 2 shows that 15.5% of the boys in the sample bully or are cruel to others and 10.5% break things on purpose *sometimes or often*, as reported by the primary caregiver. As expected, only a small percentage of primary caregivers report that their children engage in these behaviors *often* (2% and 1.5%, respectively).

Cross-tabulations of child- and parent-reports reveal that there is little overlap between the two measures of violence. For example, 80% of parents of children who self-report that they seriously hurt someone do not report that their child

[15] In waves 2 and 3, all children were sent the time diaries and close to 90% of the sample completed them. In wave 4, only half of the sample were sent the time diaries and time diary completion rate was lower.

[16] These estimates can be made available upon request.

[17] In CDS 2014, the delinquency questions were not included into the initial public release data and were obtained upon signing an agreement with the Institute for Social Research at the University of Michigan.

[18] There is also a slight difference in the wording of one of the questions. In 2014, children are asked "In the last 6 months, about how many times have you hurt someone badly enough that he or she needed to see a doctor or needed to receive medical care?". This could explain the decline in self-reported aggression in 2014, as "needing bandages" may not be interpreted as "needing medical care". The wording of the question about destruction of school property is the same across years.

Table 4
Effects of popular video game releases on daily weekday video game hours.

	(1)		(2)		(3)		(4)	
M-rated game released								
0–1 months ago	−0.102	(0.090)	−0.153	(0.097)	−0.038	(0.094)	−0.052	(0.103)
1–2 months ago	0.109	(0.095)	0.038	(0.109)	0.032	(0.102)	−0.034	(0.115)
2–3 months ago	0.022	(0.097)	−0.081	(0.110)	0.044	(0.120)	0.047	(0.121)
3–4 months ago	0.241**	(0.114)	0.214*	(0.119)	0.146	(0.128)	0.141	(0.137)
4–5 months ago	0.296***	(0.086)	0.343***	(0.116)	0.365***	(0.132)	0.436***	(0.146)
5–6 months ago	−0.087	(0.080)	−0.061	(0.091)	−0.051	(0.107)	−0.051	(0.111)
T-rated game released								
0–1 months ago	–		0.241	(0.152)	–		0.317*	(0.178)
1–2 months ago	–		0.112	(0.108)	–		0.020	(0.118)
2–3 months ago	–		0.241*	(0.138)	–		0.336**	(0.147)
3–4 months ago	–		0.066	(0.130)	–		0.045	(0.144)
4–5 months ago	–		−0.021	(0.108)	–		−0.119	(0.116)
5–6 months ago	–		−0.041	(0.097)	–		−0.012	(0.099)
E-rated game released								
0–1 months ago	–		–		0.018	(0.093)	−0.077	(0.102)
1–2 months ago	–		–		0.242**	(0.105)	0.220*	(0.112)
2–3 months ago	–		–		−0.143	(0.144)	−0.345**	(0.172)
3–4 months ago	–		–		0.212**	(0.098)	0.148	(0.117)
4–5 months ago	–		–		0.103	(0.106)	0.076	(0.114)
5–6 months ago	–		–		−0.012	(0.116)	0.002	(0.125)
Mean (dep var)	0.750		0.750		0.750		0.750	
R-squared	0.031		0.036		0.038		0.046	
Sample size	2056		2056		2056		2056	

Notes: Popular video games are 10 best selling video games each year within each video game category. The sample includes 8–18 year old boys who completed time diaries. Standard errors (clustered at the 1968 household level) are presented in parentheses. All regressions control for the household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

bullies or is cruel to others, and conversely, 74% of children whose parents report that their child bullies or is cruel to others do not report that they hurt someone. On the one hand, it is not surprising to find these discrepancies, because the questions asked to children and parents are not the same. For example, a child can bully other children without physically hurting them. Thus, the child-report is a more precise measure of physical violence, but does not measure psychological abuse. On the other hand, there may be more measurement error in parent-reports. Parents may be unwilling to admit to the interviewer that their children have behavioral problems because of the fear that it reflects badly on them. I expect children to be less concerned about these image/stigma issues and provide more truthful answers, especially because their answers are collected confidentially. Moreover, parents do not observe children outside home and may not be aware of their delinquent behaviors. For these reasons, child-reports are preferred measures of violence in this analysis.

5. Results

5.1. New popular violent video games and children's video game hours

In this subsection, I demonstrate that video game hours indeed increase after a new popular violent video game is released. Column (1) of Table 4 shows that four and five months after a release of a popular M-rated video game, 8–18 year old boys spend 0.241 and 0.296 more hours (15–20 more minutes) per day playing video games on weekdays. These are sizeable increases relative to the mean of 0.75 h per day (by 32–39%). No statistically significant changes are observed in the earlier or later months. There are several possible explanations for a delay in response to a release of a new M-rated video game. First, these video games are quite expensive and are not supposed to be sold to children under 17 years of age. Most children need to get their parents to buy them the game, who may initially be reluctant to do it. Second, the prices of video games tend to drop several months after a release. Finally, it takes a while for the pirated (illegal) copies of games to appear online.

Table 4 shows that the results are robust to controlling for the releases of T-rated games (column 2), but the coefficient on the four month lag decreases and the coefficient on the fifth lag increases, when the releases of E-rated games are controlled for (column 3).[19] This suggests that there is no correlation between the release dates of M-rated and T-rated

[19] The results are similar if I control for the releases of both T-rated and E-rated games (column 4). In this specification, the releases of T-rated games are found to increase children's video game hours one and three months after. The releases of E-rated games increase children's video game hours two months after, but decrease their video game hours three months after. A possible explanation for the latter negative effect is that children take a break from video game playing after intensely playing video games in the previous month.

Table 5
Effects of popular M-rated video game releases on daily weekday video game hours: heterogeneity.

	Girls	Boys						
		Age		Plays VGs		Diary: child		
	All	< 12 yrs	≥ 12 yrs	No	Yes	No	Yes	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M-rated game released								
0–1 months ago	−0.011	−0.098	−0.138	−0.306***	−0.031	−0.109	−0.164	−0.063
	(0.041)	(0.121)	(0.124)	(0.114)	(0.105)	(0.108)	(0.131)	(0.087)
1–2 months ago	0.044	0.019	0.135	−0.050	0.144	−0.034	0.225*	0.130
	(0.040)	(0.139)	(0.118)	(0.099)	(0.109)	(0.124)	(0.117)	(0.098)
2–3 months ago	0.059	0.113	0.014	0.099	−0.014	0.179	−0.057	0.060
	(0.044)	(0.136)	(0.126)	(0.084)	(0.114)	(0.147)	(0.124)	(0.103)
3–4 months ago	0.015	0.001	0.354**	0.010	0.271**	0.092	0.263*	0.285**
	(0.048)	(0.125)	(0.160)	(0.115)	(0.136)	(0.165)	(0.156)	(0.118)
4–5 months ago	0.036	0.194	0.331***	−0.098	0.380***	0.015	0.350***	0.279***
	(0.037)	(0.127)	(0.112)	(0.086)	(0.098)	(0.114)	(0.114)	(0.086)
5–6 months ago	0.013	−0.012	−0.121	0.006	−0.083	0.146	−0.083	−0.068
	(0.046)	(0.107)	(0.103)	(0.098)	(0.092)	(0.127)	(0.098)	(0.082)
In 0–1 months	–	–	–	–	–	–	–	0.121
								(0.093)
Mean (dep var)	0.179	0.585	0.835	0.194	0.832	0.567	0.827	0.750
R-squared	0.013	0.049	0.032	0.164	0.037	0.049	0.036	0.032
Sample size	2002	683	1368	224	1753	637	1378	2056

Notes: Popular M-rated video games are 10 best selling video games each year within M-rated category. The sample includes children aged 8–18 years old who completed time diaries. Standard errors (clustered at the 1968 household level) are presented in parentheses. All regressions control for the child and household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

games, but the releases of M-rated and E-rated games are correlated. I will, therefore, check the robustness of the results to controlling for the significant lags of E-rated (and T-rated) game releases.

The relationship between weekend video game hours and M-rated video game releases is weaker, as shown in Online Appendix Table A.1. Although the coefficients on M-rated video game releases are of similar sizes as in the regressions of weekday video game hours, they are less precisely estimated. For this reason, in the following analyses I will use weekday video game hours.

Table 5 presents the results of regressions that may be considered as placebo tests. In particular, I check whether the response to popular violent video game releases is smaller in the sub-groups that are less likely to be interested in these games: girls, younger boys, and boys who do not regularly play video games[20] The results presented in columns (1) to (5) show that this is, indeed, the case. M-rated video game releases do not have any effects on video game hours of girls. Among boys, the increase in weekday video game hours is driven by older boys and regular video game players. In columns (6) and (7), the sample is split by whether the child participated in the completion of the time diary. It is expected that video game hours are measured more accurately, if the child either completed the diary himself or helped the parent to do that. In turn, the effects of video game releases should be larger and more statistically significant in the latter sub-sample of boys. The results support this conjecture. It should be noted, however, that older boys are more likely to participate in time diary completion, thus these results are somewhat confounded with age effects. Finally, in column (7), I add a one month lead of popular violent video game release and find that it is not statistically significant.[21]

5.2. Violent video games and children's violent behavior

I now turn to the effects of new violent video games on violent behavior among 8–18 year old boys. As explained in Section 3, child and parent reported violence measures are regressed on average predicted daily video game hours in the past six months[22] For the prediction of video game hours, I use the two significant lags (fourth and fifth) of M-rated game releases.[23] To check whether there is sufficient identifying variation in children's predicted video game hours, I regress their predicted hours on the control variables and in Fig. 2 plot the distribution of the residuals of this regression. Fig. 2 shows that predicted video game hours do vary across children when the control variables are held fixed, but not very widely.

[20] Regular video game players are boys who play video game at least once a week as self-reported in the Child questionnaire. They constitute a majority of all boys (89%).

[21] The coefficient on the lead does not necessarily need to be equal to zero, as children may play more (or less) video games in anticipation of a release of a new game. For example, the demand for earlier titles (versions) of a game often increases before a new version is released.

[22] Specifically, in the regressions of child (parent) reported violence, children's video game hours are predicted and averaged over the six months before child (PCG) questionnaire date.

[23] Omitting the other lags does not affect the coefficient on the fourth and fifth lags: they equal 0.252 (0.102) and 0.271 (0.073), respectively.

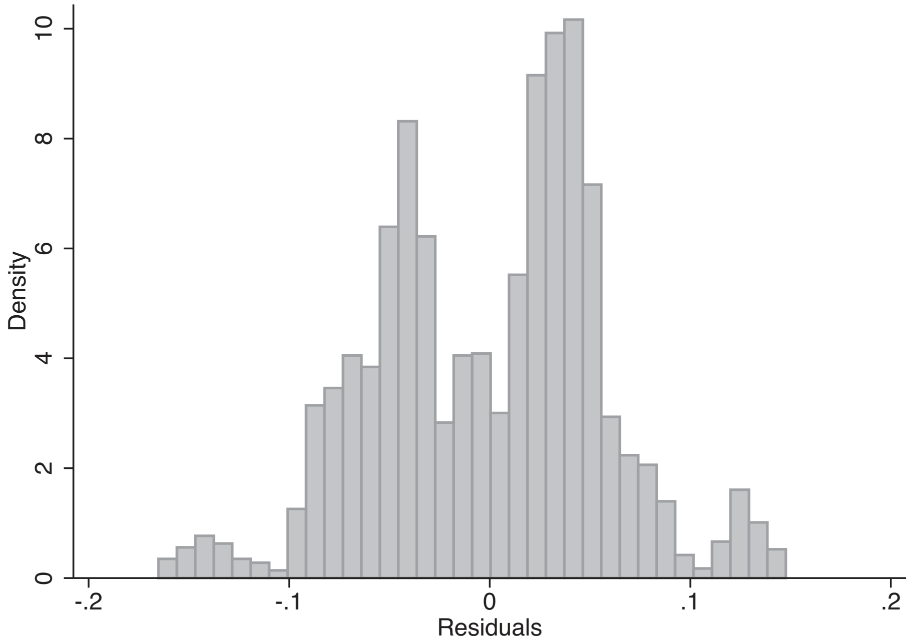

Fig. 2. Histogram of predicted video game hours' residuals. *Notes*: The sample consists of 3111 8–18 year old boys. The figure presents the distribution of the residuals of a regression of predicted video game hours on the control variables listed in Table 3 as well as season and year effects.

Table 6
Effects of predicted daily weekday video game hours on violence: sensitivity to the number of bootstrap replications.

	Aggression against others		Destructive behavior	
	Child-report	Parent-report	Child-report	Parent-report
Coefficient	−0.178	−0.031	−0.106	0.156
S.E.: 500 replications	(0.115)	(0.112)	(0.103)	(0.094)*
S.E.: 1000 replications	(0.113)	(0.112)	(0.103)	(0.095)
S.E.: 1500 replications	(0.114)	(0.110)	(0.104)	(0.095)*
S.E.: 2000 replications	(0.114)	(0.110)	(0.104)	(0.095)
S.E.: 2500 replications	(0.114)	(0.110)	(0.105)	(0.096)
S.E.: 3000 replications	(0.115)	(0.110)	(0.105)	(0.096)
S.E.: 3500 replications	(0.116)	(0.109)	(0.105)	(0.096)
S.E.: 4000 replications	(0.117)	(0.109)	(0.105)	(0.096)
S.E.: 4500 replications	(0.116)	(0.110)	(0.105)	(0.096)
S.E.: 5000 replications	(0.117)	(0.109)	(0.105)	(0.096)
Mean (dep var)	0.182	0.155	0.127	0.105
Sample size	1586	3111	1586	3111

Notes: Standard errors are calculated using bootstrap and clustered at the 1968 household level. In columns (1) and (3), the sample consists of 12–18 year old boys. In columns (2) and (4), the sample consists of 8–18 year old boys. All regressions control for the child and household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

The standard variation of the residuals is equal 0.057 h and the minimum and maximum values are −0.165 and 0.148, respectively.

Table 6 presents the estimated effects of the ordinary least squares (OLS) regressions of violence on predicted video game hours as well as standard errors calculated using 500–5000 bootstrap replications (allowing for clustering at the 1968 household level). The standard errors stabilize after 3500 replications in all regressions. Therefore, the rest of the tables present standard errors calculated using 3500 replications. Given that all dependent variables are binary, I also have estimated probit models. The average partial effects based on the probit models are very similar to the coefficient estimates of the linear probability models, as shown in Online Appendix Table A.2. For this reason, the rest of the violence regressions are estimated using the OLS.

Table 6 shows that a one-hour increase in video game playing (due to popular violent game releases) is estimated to decrease the probability of seriously hurting someone by 17.8 percentage points, as reported by children. This effect is not statistically significant at conventional levels (p-value = 0.124), but increases by more than 1.1 percentage points can be ruled out with 90% confidence. No statistically significant effect is found on bullying, as reported by parents. Turning to

Table 7
Effects of predicted daily weekday video game hours on violence: heterogeneity.

	Aggression against others		Destructive behavior	
	Child-report (1)	Parent-report (2)	Child-report (3)	Parent-report (4)
A. Child and household characteristics				
Reading skills ≤ median	−0.151	−0.221*	−0.160	0.169
	(0.139)	(0.122)	(0.119)	(0.103)
Reading skills > median	−0.340	−0.275	−0.048	0.103
	(0.232)	(0.266)	(0.215)	(0.211)
PCG education ≤ 12 years	−0.047	0.026	−0.104	0.208**
	(0.153)	(0.121)	(0.129)	(0.098)
PCG education > 12 years	−0.260	−0.243	−0.046	0.028
	(0.164)	(0.204)	(0.131)	(0.170)
HH equivalized income ≤ median	−0.111	0.052	−0.015	0.163
	(0.157)	(0.124)	(0.140)	(0.108)
HH equivalized income > median	−0.399	−0.046	−0.018	0.097
	(0.301)	(0.298)	(0.271)	(0.243)
B. Type of violence				
Non-realistic violence	−0.759**	−0.059	−0.102	0.541
	(0.383)	(0.532)	(0.350)	(0.437)
Realistic violence	−0.158	0.031	−0.053	0.234
	(0.209)	(0.162)	(0.178)	(0.149)
C. CDS wave				
CDS 2002 and 2007	−0.305*	−0.011	−0.146	0.255**
	(0.158)	(0.155)	(0.136)	(0.124)
CDS 2014	−0.039	0.299**	0.188	0.145
	(0.116)	(0.145)	(0.123)	(0.151)

Notes: Each estimate comes from a separate regression model. Standard errors (presented in parentheses) are calculated using bootstrap with 3500 replications and clustered at the 1968 household level. In columns (1) and (3), the sample consists of 12–18 year old boys. In columns (2) and (4), the sample consists of 8–18 year old boys. All regressions control for the child and household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

destructive behavior, an increase in video game hours following a release of a violent video game is not found to significantly affect the probabilities of damaging school property and breaking things on purpose (as reported by children and parents, respectively). The latter probability is estimated to increase by 15.6 percentage points, but p-value equals 0.104.

The estimates reported in Table 6 may seem large, but an additional hour of video game playing per day corresponds to a 135% increase relative to the mean. Recall that among 8–18 year old boys a release of a new video game is found to increase video games hours only by 0.241 and 0.296 four and five months after the release, respectively (see Table 4). Among 12–18 year old boys, the corresponding figures are 0.354 and 0.331 (see Table 5). Based on back-of-the-envelope calculations, a release of a popular violent game decreases child reported aggression by 6.3 and 5.9 percentage points and increases parent reported destructive behavior by 3.8 and 4.6 percentage points four and five months after.[24] These are still sizeable effects relative to the means of violence variables (corresponding to 32–35% decrease in child reported aggression and 36–44% increase parent reported destructive behavior), although they should be used with caution given the low precision of the estimates.

5.2.1. Heterogeneity

The statistically insignificant effects of violent video games on violence in the full sample may mask significant positive or negative effects in subsamples of 8–18 year old boys. In Panel A of Table 7, I present the estimates of violence regressions by the child's cognitive (reading) skills[25] and the socioeconomic status (SES) of the family, as measured by primary caregiver's education and family's income. There are two reasons we may see variation in the effects of violent video games by these characteristics. First, the effects of predicted video game hours on violence may be identified more precisely in the subsamples where the response of children's video game hours to the releases of popular M-rated games is stronger. Online Appendix Table A.3 shows that these are children with lower cognitive skills and children from lower SES families.[26] Second, the direct effect of violent video games on violence itself may vary by child's cognitive skills and family's SES. Children with better cognitive skills may better able to control any aggressive emotions and thoughts caused by violent video games. The

[24] These calculations are made by multiplying the effects of predicted video game hours on violence from Table 6 by the effects of video game releases on video game hours from Tables 4 and 5.

[25] As a measure of cognitive skills I use the scores of two reading tests administered during the child interview (Letter Word to test children's basic reading skills and Passage Comprehension to test more advanced skills), because reading skills are unlikely to be affected by video game playing. Principal component factor analysis is performed to create one standardized index of reading skills.

[26] Children with higher cognitive skills and academic ability may be less interested in violent video games. Higher SES may be correlated with higher parental awareness about the content and perceived harm of violent video games and monitoring of children's activities.

family's SES may be correlated with parenting style, which in turn may affect children's reactivity. The substitution effect may also vary: for boys with low cognitive skills and boys from low SES families video game playing is more likely to replace violence related activities. The latter two pathways (direct and substitution) work in different directions. The results discussed below suggest that the differences in the direct effect dominate the differences in the substitution effect.

Panel A of Table 7 shows that violent video games reduce child reported violence to a larger extent among boys with *higher* cognitive skills and SES (as measured by primary caregiver's education). In these subsamples, the effects of predicted video game hours are large (−34.0 ppt for boys with higher than median reading skills and −26.0 ppt for boys of parents with more than 12 years of education), but not statistically significant (*p*-values equal 0.144 and 0.113). The effect of violent video games on parent reported destructive behavior, on the other hand, is larger among children with *lower* cognitive skills and SES, although it is statistically significant only among lower SES children. Predicted video game hours are found to increase parent reported destructive behavior by 16.9 ppt and 20.8 ppt among children with lower reading skills and less educated parents, respectively; the corresponding *p*-values are 0.101 and 0.034.

In panel B of Table 7, I look separately at the effects of realistic and non-realistic violent video games. It is expected that children would be more negatively affected by realistic violence. There may be differences in selection and substitution effects too: children who are attracted to video games with realistic violence may be more innately violent and more likely to engage in activities resulting in violence if they did not play video games.[27] I find that non-realistic violent video games substantially (by 75.9 ppt) reduce child reported aggression against others (statistically significantly at 5%), whereas the estimated effect of realistic violent video games is much smaller in magnitude (−0.158 ppt) and statistically insignificant. According to the point estimates, non-realistic violent video games also have a larger effect on parent reported destructive behavior than realistic video games, but neither effect is statistically significant.

I also estimate the regressions of parent and child reported violent behavior separately for waves 2–3 and wave 4, as the prevalence of child reported violence is substantially smaller in wave 4.[28] Furthermore, the recently released games differ from the games released in a decade ago in terms of the quality of their graphics (Stransky, 2018) and networking capabilities (Plante, 2016). The better quality games may leave more impression on children, and violence in video games may also have more impact on children if they play against other real people. The results, presented in Panel C of Table 7, suggest that the baseline results are driven by waves 2 and 3. In 2002 and 2007, violent video games are found to statistically significantly (by 30.5 ppt) reduce child reported aggression, whereas in 2014 the effect is small and statistically insignificant. Violent video games are also found to increase parent reported aggression against others in 2014 (by 29.9 ppt, significant at 5%), but not in 2002 and 2007. These differences are consistent with changes in violent video games over time, discussed above. On the other hand, the effect of violent video games on parent reported destructive behavior is larger (25.5 ppt versus 14.5 ppt) and only statistically significant in 2002 and 2007. The insignificant effects in 2014 may also be explained by smaller sample sizes, especially in the estimations of the effects on child reported violence.

It should be noted that none of the differences in violent video game effects across subsamples, types of games, and waves are statistically significant due to large standard errors; therefore, the conclusions about the heterogeneity in violent video game effects are tentative.

5.2.2. Sensitivity analysis

In this subsection, I first check sensitivity of the results to the exclusion of children whose video game hours are less affected by violent video releases: children under 12 years of age,[29] children who do not play video games regularly, and children who were not involved in the completion of the time diary. The results are presented in panels B to D of Table 8, and panel A repeats the baseline results. Excluding younger children makes the estimated effect of violent video games on destructive behavior somewhat larger (20.2 percentage points) and more precise (significant at 5%). The estimated effect on parent reported aggression against others remains negative and statistically insignificant. Most of the results are not affected by the exclusion of irregular video game players or children who did not participate in time diary completion. However, the estimated effect of predicted video game hours on parent-reported destructive behavior becomes larger (20.6 percentage points) and statistically significant at the 5% significance level.

As a second sensitivity check, I control for the releases of T-rated and E-rated video games.[30] Table 4 suggests that there may be correlation between M-rated and E-rated game releases, which may confound the effects of violent and non-violent video games. Panel A of Table 9 shows that this is not a major concern. Controlling for E-rated and T-rated game releases reduces the magnitude of the coefficients on predicted video game hours, but only somewhat. For example, the estimated

[27] Online Appendix Table A.4 presents the estimates of the regressions of video game hours on realistic and non-realist violent video game releases. Columns (1) and (2) show that both realistic and non-realist violent video game releases increase video game hours, although realistic violent video game releases increase video game hours to a larger extent. In the final prediction model, I include the lags that remain significant when both realistic and non-realistic violent game releases are included (column 3): fourth lag of non-realistic violent game releases (not significant at the conventional levels, but *p*-value(0.101) is close to 0.1), and fifth and sixth lag of realistic violent game releases. In the estimation the effect of non-realistic video games I hold the releases of realistic violent games constant when predicting children's video game hours, and vice versa.

[28] Online Appendix Table A.5 shows that boys' video game hours respond positively to popular M-rated game releases four and/or five months ago in all the waves (not statistically significantly in wave 3).

[29] This only affects parent reported behavior, as no child reported measures of violence are available for children under 12 years of age.

[30] Only significant lags of T- and E-rated video game releases are included in the regressions, which are the first and third lags of T-rated game releases and the second and fourth lags of E-rated game releases.

Table 8
Effects of predicted daily weekday video game hours on violence: sensitivity analysis.

	Aggression against others		Destructive behavior	
	Child-report (1)	Parent-report (2)	Child-report (3)	Parent-report (4)
A. Baseline				
Predicted daily VG hrs	−0.178	−0.031	−0.106	0.156
	(0.116)	(0.109)	(0.105)	(0.096)
B. 12–18 year old children				
Predicted daily VG hrs	−0.178	−0.095	−0.106	0.202**
	(0.116)	(0.103)	(0.105)	(0.087)
C. Regular video game players				
Predicted daily VG hrs	−0.151	−0.131	−0.063	0.147
	(0.121)	(0.115)	(0.109)	(0.092)
D. Children involved in diary completion				
Predicted daily VG hrs	−0.157	−0.026	−0.093	0.206**
	(0.127)	(0.096)	(0.114)	(0.081)

Notes: Each estimate comes from a separate regression model. Standard errors are calculated using bootstrap with 3500 replications and clustered at the 1968 household level. In column (1) and (3), the sample consists of 12–18 year old boys. In columns (2) and (4), the sample consists of 8–18 year old boys. All regressions control for the child and household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

Table 9
Effects of predicted daily weekday video game hours on violence: M-rated versus T-rated and E-rated games.

	Aggression against others		Destructive behavior	
	Child-report (1)	Parent-report (2)	Child-report (3)	Parent-report (4)
A. M-rated games controlling for E- and T-rated games				
Predicted daily VG hrs	−0.133	−0.021	−0.082	0.123
	(0.091)	(0.087)	(0.082)	(0.077)
B. T-rated games controlling for E- and M-rated games				
Predicted daily VG hrs	−0.372*	−0.008	0.270	0.008
	(0.207)	(0.213)	(0.194)	(0.188)
C. E-rated games controlling for T- and M-rated games				
Predicted daily VG hrs	−0.228	−0.143	−0.023	−0.025
	(0.292)	(0.185)	(0.237)	(0.146)

Notes: Each estimate comes from a separate regression model. Standard errors (presented in parentheses) are calculated using bootstrap with 3500 replications and clustered at the 1968 household level. In column (1) and (3), the sample consists of 12–18 year old boys. In columns (2) and (4), the sample consists of 8–18 year old boys. All regressions control for the child and household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

effect of violent video game playing on child reported aggression against others changes from −17.8ppt to −13.3 ppt (p-value increases from 0.124 to 0.147) and the effect on parent reported destructive behavior from 0.156 to 0.123 (p-value increases only slightly from 0.104 to 0.109).

In panels B and C of Table 9, I also present the estimated effects of T-rated and E-rated video games on children's violent behavior (controlling for M-rated and E-rated or T-rated game releases, respectively). T-rated video games are found to reduce child reported aggression against other substantially (by 37.2 percentage points) and significantly (at 10%), more so than M-rated video games. T-rated games are not found to affect any other measures of violence significantly, including parent reported destructive behavior. The differences in the effects of M-rated and T-rated video games support the idea that the net effect of video games is a combination of direct, substitution, and selection effects. T-rated games include some violence, but not to the same extent as M-rated games, and therefore are expected to have smaller direct effect on violence. On the other hand, T-rated games contain features (such as fighting, battles, etc.) that may be attractive to children who tend to engage in violence-related activities; when they play video games they cannot engage in these activities which in turn reduces violence. E-rated games are not found to statistically significantly affect any of the violence measures. A possible explanation is that E-rated games are of no interest to children prone to violence; thus there is no substitution effect.

5.2.3. Other behavioral problems

In this subsection, I check whether violent video games have impact on any of the other behavioral outcomes of children. Table 10 presents the estimated effects on parent reported externalizing and internalizing behavior problems, positive behaviors, other child reported delinquencies besides violence, and children's experiences of bullying. All the measures are standardized. Online Data Appendix B.5 provides details on the construction of these measures. Based on the point estimates presented in columns (1)–(3), children's externalizing and internalizing behaviors decrease and positive behaviors increase following the releases of popular M-rated games, as reported by parents (by -13.7%, -32.6%, and 53.6% of a standard devia-

Table 10
Effects of predicted daily weekday video game hours on other behaviors.

	Parent reported			Child reported	
	Externalizing behaviors (1)	Internalizing behaviors (2)	Positive behaviors (3)	Other delinquencies (4)	Bullying (5)
Predicted daily VG hrs	−0.137	−0.326	0.536	0.125	−0.338
	(0.314)	(0.310)	(0.331)	(0.279)	(0.338)
Mean (dep var)	−0.009	0.006	−0.030	0.004	0.000
R-squared	0.049	0.036	0.037	0.064	0.019
Sample size	3101	3082	2570	1518	2227

Notes: Each estimate comes from a separate regression model. Standard errors (presented in parentheses) are calculated using bootstrap with 3500 replications and clustered at the 1968 household level. In columns (1)–(3) and (5), the sample consists of 8–18 year old boys. In column (4), the sample consists of 12–18 year old boys. All dependent variables are standardized indices so that their means equal 0 and standard deviations equal 1. Aggression against others and destructive behavior are excluded from the externalizing behavior and delinquency indexes. All regressions control for the child and household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

tion, respectively), but none of these effects are statistically significant. In Online Appendix Table A.6, I investigate whether any of the specific externalizing, internalizing, and positive behaviors are significantly affected by violent video games. Most of the coefficients on internalizing and externalizing behaviors are negative, and most of the coefficients on positive behaviors are positive and a few are statistically significant. In particular, children are found to be less likely to “hang around with bad kids” following a release of a popular violent video game (by 22.8 percentage points). This finding suggests video game playing may indeed substitute for violence-related activities. According to parents, children are also less likely to be impulsive and more likely to be self-reliant (by 95.1% and 65.4% of a standard deviation, respectively). Although the latter positive changes in children’s behavior may be related to video game playing, an alternative explanation is that children behave better after a new game is released in order to get their parents to buy them this game.

Columns (4) and (5) of Table 10 show no statistically significant effects of violent video games on child reported delinquency[31] and bullying indexes. To investigate further, I regress each delinquency and bullying measure on predicted video game hours. Online Appendix Table A.7 shows that the probabilities of the child being hit and having their things taken by other kids decrease when a child’s video game hours increase by one hour (by 21.1 ppt and 15.4 ppt, respectively), but not statistically significantly at the conventional levels (p-values are 0.109 and 0.107, respectively). Modest size increases in these probabilities can be ruled out with the 90% confidence. These results are consistent with the main finding that children are not more likely to hurt other people following a release of a violent video game. Together they suggest that newly released violent video games do not contribute to conflicts between children.

5.2.4. Substitution

To complete the results section, I use the time diary data to investigate the importance of the substitution effect. I first regress the time spent on different activities on predicted video game hours to check what activities are displaced by an increase in video game playing following a release of a popular violent video game. The estimates of these regressions (for all 8–18 years old boys and for 12–18 years old boys for whom self-reports of violence are available) are presented in panel A of Table 11. They all are statistically significant at 1% (as are the rest of the estimates in this table). In both samples, an increase in the time spent playing video games comes at the cost of the time spent studying. A one-hour increase in video game playing per day decreases study time by 2.279 h and 1.284 h among all and older boys, respectively. Note that the reductions in study time exceed one hour; this is because the time spent on some activities in fact increases as boys spend more time playing video games. Some of these activities (Internet-related, television watching, and socializing with friends) may be complementary to video game playing. The largest increase is, however, in active leisure (by 1.2 h and 0.616 h per day among 8–18 and 12–18 year old boys, respectively), which may be explained by children reporting video game playing as other leisure activities, such as non-electronic games.[32]

In panel B of Table 11, I investigate whether children spend more or less time with other children following a release of a violent video game. According to the results presented in panel A, children spend more time socializing with friends as a main activity. Children may, however, interact with other children while doing other activities as well, in which case, socializing would be not recorded as a separate activity in the time diary. In the CDS time diaries, children are also asked who was participating in or was around during the activity. I use this information to construct the measures of the time spent with friends and siblings, which are then regressed on predicted video game hours. The time spent with friends is found to increase in both full sample (by 1.026 h/day) and the subsample of older boys (by 0.747 h/day). The time spent with siblings also increases overall (by 0.763 h/day), but not among older boys who spend slightly less time with their

[31] Excluding hurting others and destroying school property.

[32] This implies that video game hours may be measured with error, which may explain low precision of the estimates of predicted video game hours on violence.

Table 11
Effects of predicted daily video game hours on time spent on other activities, with other people, and away from home.

	All		≥ 12 yrs	
	(1)		(2)	
A. Other activities				
Internet	0.024***	(0.000)	0.023***	(0.000)
Television	0.005***	(0.001)	−0.182***	(0.001)
Socializing w/ friends	0.228***	(0.000)	0.099***	(0.000)
Active leisure	1.200***	(0.003)	0.616***	(0.000)
Passive leisure	−0.075***	(0.001)	−0.146***	(0.000)
Communication	−0.137***	(0.002)	−0.080***	(0.002)
Sleep	−0.027***	(0.002)	−0.197***	(0.001)
Studying	−2.279***	(0.004)	−1.284***	(0.002)
Other	0.060***	(0.000)	0.151***	(0.001)
B. With whom?				
Friends participating/around	1.026***	(0.001)	0.747***	(0.000)
Siblings participating/around	0.763***	(0.004)	−0.042***	(0.005)
C. Where?				
Away from home	−1.251***	(0.000)	−0.541***	(0.001)
Sample size	2056		1097	

Notes: Each estimate comes from a separate regression model. Standard errors (presented in parentheses) are calculated using bootstrap with 3500 replications and clustered at the 1968 household level. In column (1), the sample consists of 8–18 year old boys, and in column (2), the sample consists of 12–18 year old boys. All regressions control for the child and household characteristics listed in Table 3, season, and year effects. *denotes statistical significance at the 10% level, **denotes statistical significance at the 5% level, and ***denotes statistical significance at the 1% level.

siblings when a popular violent video game is released. One explanation for these findings is that children get together to play new video games.

It matters, however, not only with whom children spend time, but also where. Violent interactions between children are more likely to occur outside home environment. In the CDS time diaries, the location where each activity took place is recorded. I use this information to construct a measure of the time spent away from home and regress it on boys' predicted video game hours. The estimates of these regressions are presented in panel C of Table 11. They show that boys spend less time outside home after a release of a popular video game. As video game playing increases by an hour per day, the time spent outside home decreases by 1.251 h/day and and 0.541 h/day among 8–18 and 12–18 year old boys, respectively. These results imply that after a release of a popular violent video game, children substitute outside-home activities with video game playing, which is mainly home based activity. The substitution between video game playing and outside-home activities counteracts the direct effect of violent video games on violence and contributes to the finding of no increase in violence after violent video game releases.

6. Conclusion

This study examines the question of whether there is a relationship between violence in video games and violence in real-life. To answer this question, I analyze how the violent behavior of 8–18 year old boys is affected by the releases of new violent video games in the United States. The releases of most popular (10 best selling) M-rated video games each year are first used to predict video game hours for every child using data on video game sales and release dates, collected specifically for this study, as well as the PSID-CDS time diaries. It is found that a release of a new popular violent video game increases 8–18 year old boys' video game hours, but with a delay (by 0.241 and 0.296 h per day four and five months after the release). These results are driven by older boys and regular video game players. No effect on girls' video game hours are found.

In the main part of the analysis, parent and child reported measures of violence are regressed on children's predicted video game hours. Effects of violent video games on two types of violence are analyzed: aggression against other people and destructive behavior (breaking or damaging things). The key finding of the paper is that violent video games do not appear to contribute to violence against people. An increase in video game playing following a release of a popular violent video game is found to decrease the probability of hurting someone badly, as reported by children, although this effect is not statistically significant at the conventional levels. More importantly, we can rule out larger than modest (1.1 percentage point) increases in violence against others with 90% confidence. No statistically significant effects on the probability of being cruel or mean to others (as reported by parents) or destructive behavior are found. In some sub-samples of children (older and those who were involved in time diary completion), however, violent video game playing is found to increase destructive behavior (as reported by parents) statistically significantly.

Taken together, the findings of the analysis suggest that all three mechanisms discussed in Section 2.2 are important: (1) direct impact of violence in video games on real-life violence, (2) substitution between video game playing and other violence-related activities, (3) selection of violence-prone boys into the newly released violent video games. On the one hand, the increase in parent reported destructive behavior following a release of a popular video game in some subsamples of children indicates that violent video games may have a direct effect on aggression, which is consistent with the findings of the laboratory experiments. Parent reported destructive behavior is the only measure of violence that is observed at home, where children are most likely to play video games. Thus, parents may observe that children's destructive tendencies increase immediately after playing a violent video game.[33] On the other hand, finding no increase in violence, despite the parent reported increase in destructive behavior, supports the existence of the substitution and selection effects. Any direct effect on violence is outweighed by the substitution away from violence-related activities and/or selection of violence-prone individuals into new popular violent video games.[34]

The result that children spend more time at home after a release of popular violent video game further suggests that the substitution effect plays an important role in reducing violence. The opportunities for violence at home are fewer than outside home, as are opportunities to engage in activities that lead to violence, such as consumption of alcohol and drugs, and hanging around with other boys. Thus, incapacitation is an important channel. The importance of the substitution effect is also supported by the finding that children are less likely to hang around with bad kids according to their parents. The result that the increase in video game hours following a release of a violent video game is driven by children with lower cognitive ability and children from lower SES families suggests that there indeed is selection of violence-prone children into new violent video games. The prevalence of violence is higher among these children.

Overall, the results of this analysis provide limited support for the introduction of additional restrictions on violent video game sales. They show that, on average, restricting children's access to violent video games would not decrease the occurrence of violence against people. A more general point is that other costs and benefits of video games besides those related to violence need to be taken into account before imposing regulations of video game sales. For example, other studies find that there is little causal evidence that spending more time playing video games contributes to children's body weight (Suziedelyte, 2015b) and that video games increase children's problem-solving ability (Suziedelyte, 2015a). On the other hand, Ward (2018) finds that high school and college students spend less time attending classes and doing homework when video game sales increase. More high quality research on video games is needed before introducing any policies.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at 10.1016/j.jebo.2021.05.014

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[33] This finding may also be explained by the fact that children spend more time at home after a popular violent video game is released; in turn, parents have more opportunities to observe children's behavior.

[34] This finding is also consistent with violent video games providing outlet for boys to release their violent emotions (as predicted by the catharsis theory) and thus having a direct reducing effect on violence in medium term.

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