Growing Up with Grand Theft Auto: A 10-Year Study of Longitudinal Growth of Violent Video Game Play in Adolescents

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Abstract

A host of studies have examined the impact of playing violent video games on aggressive behavior. However, longitudinal research is rare, and existing studies have allowed little room for individual variability in the trajectories of violent video game play. The current study used a person-centered approach to examine trajectories, predictors, and outcomes of violent video game play over a 10-year period. Three groups of individuals emerged: high initial violence (4 percent), moderate (23 percent), and low increasers (73 percent). High initial violence and moderate groups showed a curvilinear pattern of violent video game play across time, whereas low increasers group increased slightly in violent video game play across time. The high initial violence and moderate groups were more likely to be male, and those in the high initial violence group were more likely to be depressed at the initial wave. There was no difference in prosocial behavior at the final time point across all the three groups, but individuals in the moderate group displayed the highest levels of aggressive behavior at the final wave. Implications of the results are discussed.

Keywords: violent video games, aggressive behavior, prosocial behavior, media violence, video games, longitudinal research

Introduction

BY THE YEAR 2022, experts estimate that the video game industry will revenue over $230 billion,[1] and further estimate that more than half of the current top-selling video games on the market contain violence.[2] Despite decades of research on the effects of violent video games on behavior,[3] the implications for the "real-world" effects of violent video games remain highly contested. Experimental and longitudinal studies have repeatedly shown an association between playing violent video games and increased aggressive[3] and decreased prosocial[4] behaviors. Additionally, some studies have found a link between playing violent video games and depression[5] and anxiety.[6]

However, other researchers have shown that while violent video game play may be related to increased aggression in the laboratory, it is not a significant predictor of real-world violence[7] or violent crime.[8] Researchers further argue for a publication bias in violent video game research that drives the consistent relationship between violent video game play and increased aggression.[9] Longitudinal research, primarily focused on adolescents, has repeatedly shown a correlation between playing violent video games and increased aggressive behavior over time[10–13]; however, longitudinal studies examining interpersonal and dating violence did not find any association between playing violent video games and increased violence.[14] Additionally, experimental studies suggest that there is little evidence of a link between playing violent video games and depression.[15] Clearly, the effects of playing violent video games on behavior are complicated, nuanced, and require variation for individual's personality, family and peer relationships, and societal factors. Yet, limited research has longitudinally examined the effects of violent video game play on aggressive and prosocial behaviors, allowing for a person-centered approach to understanding the effects of violent video game play on behavior over time.

According to the General Aggression Model,[16] the short-term exposure to violent video games influences a person's arousal level, aggression-related cognitions, and present mood. These three factors work together to influence how a person behaves when confronted with external stimuli. Researchers have shown that across large samples, short-term exposure to violent video games, *at the group level*, is related to increased aggressive cognition,[17] decreased physiological

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arousal to violence,[18] and decreased affect.[19] However, there is significant individual variation in these effects. In the long-term, repeated exposure to violent video games is theorized to repeatedly activate and reinforce aggression-related scripts and schemas, eventually leading to increased aggressive personality, decreased prosocial behavior, desensitization, and decreased empathy.[20] However, all longitudinal research to date on the effects of violent video games on aggressive and prosocial behavior have focused on group-level differences, ignoring individual trajectories and experiences.

Traditional variable-centered approaches assume that the sample comes from a single population, which is homogeneous regarding the variables on interest.[21] However, a person-centered approach accounts for heterogeneity, grouping individuals who are similar and who share a set of characteristics that vary similarly over time. For example, adolescents who have initially high levels of violent video game use might take different trajectories of such use over time. Some adolescents might be consistently high on the amount of time spent playing violent video games over time, whereas some might dramatically increase or decrease over that same time period. Traditional variable-centered approaches do not allow us to consider these types of possibilities and how they might be related to outcomes, such as prosocial behavior, mental health, or aggression.

Thus, the aim of this study was to utilize a person-centered approach to examine violent video game play over more than a decade. This will provide a supplement to the existing variable-centered research and will aid in our understanding of developing processes regarding video game play and child behavioral and mental health outcomes. We suspect that there are different trajectories of violent video game play, but we examine these in an exploratory way in the current study.

Methods

Participants

This study was reviewed and approved by the IRB at the primary author's university. Participants included 500 adolescents who participated in [Project Masked for Review], which is an ongoing longitudinal study of inner family life involving families with a child between the ages of 10 and 13 years ($N = 500$, 51.6 percent female). The data for the current article are from Waves 3 to 11 when video games were first included in data measurement. There was a 64.47 percent retention rate between all nine waves of data collection. Participant children averaged 13.82 (standard deviation [SD] = 1.03) years of age at the start of the study (Wave 3) and 23.20 ($SD = 1.01$) years at the final wave of the study (Wave 11). Approximately 65 percent of families were Caucasian, 12 percent Black, 19 percent multiethnic, and 4 percent other. Sixty-eight (13.6 percent) participants did not report ever playing video games at any wave and were excluded from the analysis.

Procedure

Participant families were selected from a large northwestern city and interviewed during the first 8 months of 2007 for a Wave 1 data sample. Wave 3 (the first year in the current article) took place in 2009. Participants took part in the study once a year each year until Wave 10. Wave 11

(2018–2019) took place approximately 3 years after Wave 10. Families were primarily recruited using a purchased national telephone survey database (Polk Directories/ InfoUSA). Families identified using the Polk Directory were randomly selected from targeted census tracts that mirrored the socioeconomic and racial stratification of reports of local school districts. Of the 692 eligible families contacted, 423 agreed to participate, resulting in a 61 percent response rate. However, the Polk Directory national database was generated using telephone, magazine, and Internet subscription reports; as a result, families of lower socioeconomic status were underrepresented. Therefore, in an attempt to more closely mirror the demographics of the local area, a limited number of families were recruited into the study via other means (e.g., referrals, fliers; $n = 77$, 15 percent).

Participants completed questionnaires at each wave, all completed electronically. Participants were given $50 for their time. It is important to note that there were little missing data. Dropout analyses revealed that the data were missing at random and can be accessed by contacting the primary author. Missing data were handled using the maximum likelihood method in Mplus, which estimates the most likely outcome in the presence of missing data. This is superior to case deletion and allowed us to include participants who had data for at least one wave.

Measures

Video game violence (Waves 3–11). Participants listed their three favorite video games and rated how frequently they played each game on a scale of 1 (*not frequently*) to 5 (*extremely frequently*). There were a total of 789 games mentioned across the 11 waves. Each game was given a violence rating on a 0 (*no violence*) to 5 (*extreme violence*) Likert scale where we could find data ($N = 511$). Ratings were obtained using scoring from the media content coding Web site *Common Sense Media*.[22] According to the Web site, "each game is subjected to a detailed evaluation process by expert, trained reviewers, who come from every corner of the media, academic, and parenting worlds … [including] teachers, librarians, and experienced academics who've studied the impact of media at length. All are passionate about both media and Common Sense's 'sanity, not censorship' approach to providing information and have been extensively trained in our child development-based rating rubric." As an example, *Call of Duty*, *Dead Rising*, *Gears of War*, and *Grand Theft Auto* were all rated as 5, and *1010*, *American Idol*, *Bejeweled*, and *Boggle* were all rated as 0. We requested reliability statistics from the company, but they did not have the formal reliability statistics that are common in this type of research. Thus, we conducted our own reliability analysis on the ratings and found the ratings to be valid and reliable ($r = 0.80$; $SD = 0.07$). A description of this process can be found in the Supplementary Data S1.

A video game violence exposure score was obtained by multiplying content ratings for each game by frequency of game playing, thus giving more weight to games that were played more frequently.

Aggression (Wave 3 and Wave 11). Children's aggressive behavior was assessed using five items taken from Weinberger, Schwartz, and Davidson.[23] Participants rated

the degree to which items described them using a 5-point Likert scale ranging from 1 (*does not describe me*) to 5 (*describes me very well*). Sample items included, ''I use physical force when angry.'' Reliability was acceptable (Wave 3, $\alpha = 0.88$, Wave 11, $\alpha = 0.80$).

Depressive symptoms (Wave 3 and Wave 11). Adolescent depression was assessed using the 20-item, self-reported Center for Epidemiologic Studies Depression Scale for Children (CES-DC).[24] Participants responded by rating the degree to which they experienced each item in the past week, with a response scale ranging from 1 (*not at all*) to 4 (*a lot*). Sample items included, ''I was bothered by things that don't usually bother me,'' ''I felt lonely, like I didn't have any friends,'' and ''I felt like something bad was going to happen.'' Higher scores indicated greater depressive symptoms. Reliability was acceptable (Wave 3, $\alpha = 0.92$, Wave 11, $\alpha = 0.92$).

Anxiety symptoms (Wave 3 and Wave 11). Child's anxiety was assessed using the six-item generalized anxiety disorder subscale from the Spence Child Anxiety Inventory.[25] Participants responded using a 4-point Likert scale ranging from 0 (*never*) to 3 (*always*), with higher scores reflecting greater levels of anxiety. Sample items included, ''I worry a lot about things.'' Higher scores indicated increased levels of anxiety. Reliability was acceptable (Wave 3, $\alpha = 0.83$, Wave 11, $\alpha = 0.88$).

Prosocial behavior (Wave 3 and Wave 11). Prosocial behavior toward strangers was measured using five items based on the Inventory of Strengths.[26] Respondents answered on a 5-point Likert-type scale, ranging from 1 (*not like me at all*) to 5 (*very much like me*) in terms of how much they disagreed or agreed with statements about themselves. Sample statements included, ''I help people I don't know, even if it is not easy for me.'' Reliability was acceptable, although moderate at the latter wave (Wave 3, $\alpha = 0.83$, Wave 11, $\alpha = 0.65$).

Analysis plan

We conducted a growth curve (using Mplus v. 8.3) to examine how violent video game play grows over a 10-year period. If there is significant variance in the slope, we will then conduct a growth mixture model to examine class membership. We finally examine predictors and outcomes of each class using the three-step approach in Mplus.

Results

Preliminary statistics

Boys played more violent video games than girls at every wave except for Wave 7 ($p = 0.11$), Wave 8 ($p = 0.09$), and Wave 10 ($p = 0.12$). See Table 1 for means and SDs.

Main analyses

We first examined a growth curve model of violent video game play over time. Model fit was moderate [$\chi^2 (36) = 140.94$, $p < 0.001$, comparative fit index = 0.86, Tucker–Lewis index = 0.86, root-mean-squared error of approximation = 0.08]. Analyses revealed a significant intercept ($I = 1.41$, $p < 0.001$), a

TABLE 1. MEANS AND STANDARD DEVIATIONS FOR SEX DIFFERENCES FOR VIOLENT VIDEO GAME PLAY

	Girls		Boys	
Violent video game play	M	SD	M	SD
Wave 3***	4.75	4.34	6.70	5.22
Wave 4**	6.36	6.05	8.51	6.56
Wave 5**	5.56	5.31	7.67	5.70
Wave 6**	5.65	5.07	7.36	5.02
Wave 7	6.10	5.43	7.16	5.38
Wave 8	5.04	4.70	6.08	4.92
Wave 9*	5.79	6.65	7.91	7.04
Wave 10	5.90	4.94	6.99	5.23
Wave 11**	7.58	6.77	10.73	7.47

*$p < 0.05$; **$p < 0.01$; *$p < 0.001$.
M, mean; SD, standard deviation.

significant slight downward trend for participants over time ($S = -.25$, $p = 0.035$), and a significant quadratic ($Q = 0.34$, $p = 0.009$) suggesting a curvilinear trend with a sharp increase at the final wave. Figure 1 shows the estimated means. Additionally, there was a significant variance in the intercept ($\psi = 18.49$, $p < 0.001$), slope ($\psi = 1.27$, $p < 0.001$), and quadratic ($\psi = 0.01$, $p < 0.05$) suggesting multiple trajectories of violent video game play over time. We then conducted a growth mixture model to explore this possibility. Two-, three-, and four-class models were estimated. To determine the number of classes, we examined two information criteria, the Bayesian Information Criterion (BIC) and the sample size-adjusted BIC (SABIC). Given the BIC and SABIC may indicate differing numbers of classes, we also employed the LL-Diff test, examined class sizes, and took entropy (a measure of how well cases are classified) into account.

Table 2 shows the fit improvement when moving between the different classes. Fit statistics suggested improvement when moving from one class to two, and from two to three,
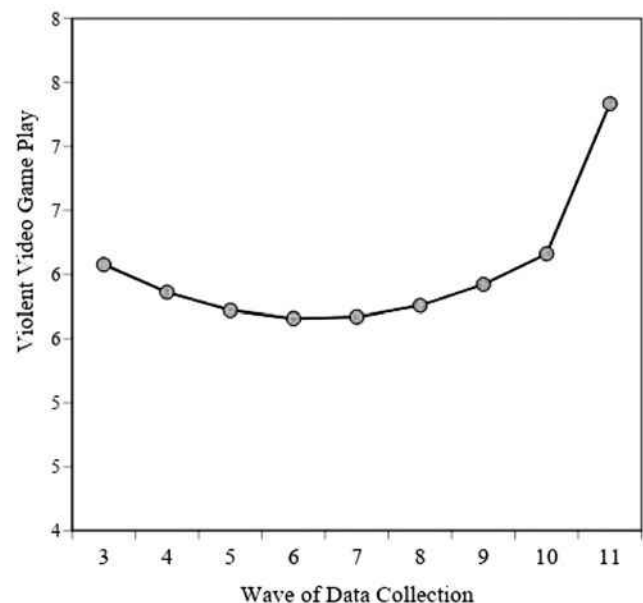

FIG. 1. Estimated change patterns of violent video game play.

TABLE 2. RELATIVE MODEL FIT BY NUMBER OF CLASSES

Classes	N	Log-likelihood	Entropy	BIC	SABIC	LLR test
1	434	−7,110.07	—	14,329.45	14,272.34	—
2	92, 342	−7,073.86	0.77	14,281.38	14,211.56	$p=0.056$
3	**19, 99, 316**	**−7,053.09**	**0.83**	**14,264.09**	**14,181.58**	**$p=0.02$**
4	23, 97, 19, 295	−7,033.81	0.81	14,248.99	14,153.79	$p=0.23$

The bold values represent the final solution chosen.
BIC, Bayesian Information Criterion; LLR, likelihood ratio; SABIC, sample size-adjusted BIC.

but not between three and four. Thus, we settled on a three-class model as the most favorable model of the data. Figure 2 shows the growth trajectories of the classes, and Table 3 shows the growth parameters for each class. Class 1 (4 percent, $n=19$) showed a very high intercept and with a steady decrease, followed by an increase at the final wave. We call this class "High Initial Violence." Class 2 (23 percent, $n=99$) had a moderate intercept with a similar curvilinear pattern to Class 1, ending up at almost the exact same levels of video game violence by the final wave. We refer to Class 2 as "Moderates." Finally, Class 3 (73 percent, $n=316$) had low initial levels of video game violence and slightly increased over time. This class is called "Low Increasers."

Next, the three-step approach in Mplus (v 8.3) was used to determine predictors of the change patterns of violent video game play and how outcome variables differ across the patterns.[23,27] Predictors included biological sex, aggression, prosocial behavior, depression, and anxiety (all at Wave 3). Outcomes included these same variables at the final wave (Wave 11). In terms of predictors, boys were more likely to be in the "High Initial Violence" group compared with the "Moderate" ($\beta=1.90$, $p=0.05$) and "Low Increasers" ($\beta=2.53$, $p=0.007$) groups. Additionally, boys were more likely to be in the "Moderate" group compared with the "Low Increasers" group ($\beta=0.63$, $p=0.03$). The "High Initial Violence" group had higher levels of initial depression than both the "Moderate" ($\beta=2.20$, $p=0.02$) and "Low Increasers" groups ($\beta=1.79$, $p=0.04$), but lower levels of anxiety ($\beta=-3.60$, $p=0.003$; $\beta=3.52$, $p=0.002$, respectively). Apart from biological sex, there were no significant differences between those in the "Moderate" and "Low Increasers" groups.

For outcomes, there were no differences in prosocial behavior, depression, or anxiety at the final wave. However, "Moderates" showed significantly higher levels of aggres-

sion than "High Initial Violence" ($\chi^2=22.55$, $p<0.001$) or "Low Increasers" ($\chi^2=24.57$, $p<0.001$).

Discussion

For all participants, violent video game play showed a quadratic pattern across the 10 years, with participants playing a significant amount of violent video games in early adolescence, decreasing in middle adolescence, and increasing again in emerging adulthood. Notably, there was a significant variability across participants in trajectories related to violent video game play across time.

The data suggested three main trajectories of violent video game play. The smallest group, called high initial violence, started very high in violent video game play during early adolescence, decreased dramatically during mid-adolescence, before increasing slightly during emerging adulthood. This group never returned to their initial level of extremely high violent video game play during the duration of the study. This pattern may suggest some type of intervention by parents or by the individual themselves, significantly altering the trajectory of these participants. This group displayed higher depressive symptoms during early adolescence but decreased anxiety. It is possible that this group was using violent video games to manage or cope with depressive symptoms. Previous researchers have shown that playing video games as a coping mechanism or distraction from mental health problems may be effective,[28,29] although these studies have failed to consider the content of video games played. However, this group also displayed lower levels of anxiety than the other two groups, suggesting perhaps a desensitization or numbing effect.[30,31] This group was no higher in aggressive or prosocial behavior at the initial time point than other groups, going against some research suggesting that aggressive adolescents specifically seek out violent video games.[32]

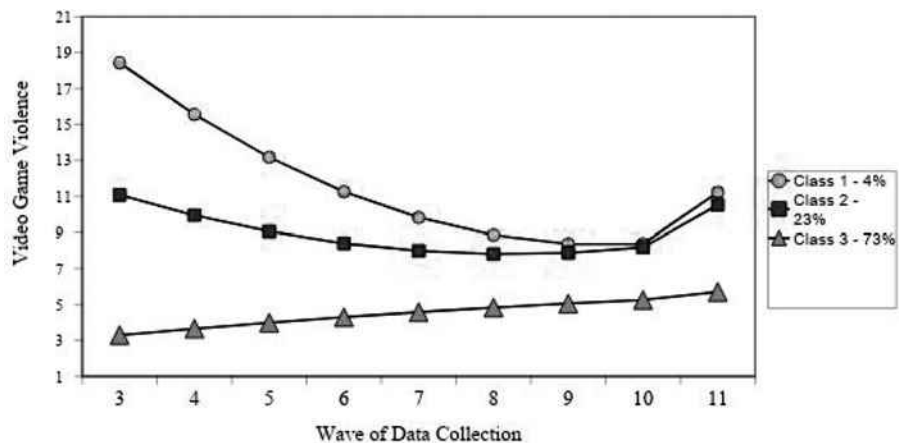**FIG. 2.** Estimated change patterns for growth mixture model of video game violence.

TABLE 3. GROWTH PARAMETERS FOR EACH CLASS

Class no. (percent of sample)	Intercept B (SE)	Linear slope B (SE)	Quadratic B (SE)
1 (4)	18.43*** (0.75)	−3.11*** (0.47)	0.24*** (0.04)
2 (23)	11.07*** (0.44)	−1.25*** (0.36)	0.12* (0.05)
3 (73)	3.29*** (0.22)	0.37** (0.13)	−0.01 (0.02)

*$p < 0.05$, **$p < 0.01$. ***$p < 0.01$.
SE, standard error.

The second group, which was ~23 percent of participants, reported moderate levels of initial violent video game play, the same curvilinear pattern of violent video game play across time, and moderate levels of violent video game play at the final time point. These participants had the highest aggression levels in emerging adulthood, even though there were no differences between the three groups in levels of aggressive behavior at the initial time point. This was somewhat counterintuitive, as according to The General Aggression Model,[16] the "high initial violence" group theoretically should have had the highest amount of aggression. Indeed, these two groups had similar video game play at the final wave, but the moderate group had markedly higher levels of aggression. It may be the sharp decrease in the high initial group, which was indicative of some major intervention or lifestyle change, whereas the moderate group was more consistent in violent game play, perhaps leading to more aggression over time. Thus, sustained violent game play over time may be more predictive of long-term outcomes as opposed to high violent game play that fluctuates dramatically over time. This speaks to the importance of a person-centered longitudinal approach, as these findings would have been masked in variable- or group-centered analyses.

Finally, low increases (73 percent of participants) started low in violent video game play but increased slightly over the decade. This group showed the healthiest pattern of behavioral and mental health predictors and outcomes when compared with the other groups. This group was no higher in aggressive behavior than the high initial violence group at the final time point, suggesting that low and slightly increasing levels of violent video game play may not be related to increased aggressive behavior across time.[8–10] Alternatively, these findings may also suggest that high initial levels when attenuated over time are a poor predictor of aggression given the lack of a difference between the two groups.

The current study has a number of strengths, including a longitudinal person-centered design, but there are limitations. The current study relied on self-report data, which are known to carry some bias. Qualitative data could contribute to the current study. Nevertheless, the current study provides evidence that of multiple violent video game trajectories, with moderate and relatively consistent play being the most likely related to increased aggressive behavior over time.

Supplementary Material

Supplementary Data S1

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