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Breuer, Johannes; Vogelgesang, Jens; Quandt, Thorsten; Festl, Ruth

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# Violent Video Games and Physical Aggression: Evidence for a Selection Effect Among Adolescents

Johannes Breuer
University of Münster

Jens Vogelgesang
University of Erfurt

Thorsten Quandt
University of Münster

Ruth Festl
University of Münster and University of Hohenheim

Longitudinal studies investigating the relationship of aggression and violent video games are still scarce. Most of the previous studies focused on children or younger adolescents and relied on convenience samples. This paper presents data from a 1-year longitudinal study of N = 276 video game players aged 14 to 21 drawn from a representative sample of German gamers. We tested both whether the use of violent games predicts physical aggression (i.e., the socialization hypothesis) and whether physical aggression predicts the subsequent use of violent games (i.e., the selection hypothesis). The results support the selection hypotheses for the group of adolescents aged 14 to 17. For the group of young adults (18-21), we found no evidence for both the socialization and the selection hypothesis. Our findings suggest that the use of violent video games is not a substantial predictor of physical aggression, at least in the later phases of adolescence and early adulthood. The differences we found between the age groups show that age plays an important role in the relationship of aggression and violent video games and that research in this area can benefit from a more individualistic perspective that takes into account both intraindividual developmental change and interindividual differences between players.

Keywords: video games, violence, aggression, adolescents, young adults

Johannes Breuer, Department of Communication, University of Münster; Jens Vogelgesang, Department of Communication, University of Erfurt; Thorsten Quandt, Department of Communication, University of Münster; Ruth Festl, Department of Communication, University of Münster, and Department of Communication, University of Hohenheim.
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Correspondence concerning this article should be addressed to Johannes Breuer, Department of Communication, University of Münster, Bispinghof 9-14, 48143 Münster, Germany. E-mail: johannes.breuer@uni-muenster.de

From the earliest investigations into the relationship of video game[1] use and aggression in the 1980s (Cooper & Mackie, 1986; Dominick, 1984; Silvern & Williamson, 1987; Winkel, Novak, & Hopson, 1987) until today, hundreds of experimental and correlational studies have been conducted. Despite the large number of studies, the debate about the link between video games and aggression is ongoing, not only in politics and the mass media, but also within academia (Bushman & Huesmann, 2014; Elson & Ferguson, 2014a, 2014b; Krahé, 2014; Warburton, 2014). While all of the available meta-analyses (Anderson et al., 2010; Ferguson, 2007; Ferguson & Kilburn, 2009; Sherry, 2001, 2007) found a relationship between aggression and the use of (violent) video games, the size and interpretation of this connection differ largely between these studies; as do the definitions and measurement of violent content and

[1] We use the term video games as an umbrella term that includes all types of digital games, whether they are played on a PC, home consoles, handhelds, or mobile devices. We decided to use "video game" because it is the most common term in the literature and it is easier to read than the composite "computer and video games" or the more academic denomination "digital games."

aggression in the studies that were included in these meta-analyses. In addition, some meta-analyses only found a relationship for aggressive thoughts or feelings, but not for aggressive behavior. There is also a controversy about what exactly causes this link and, most importantly, about the direction of the (potential) effects.

Experimental research on video games and aggression has been criticized for a lack of ecological validity and the unstandardized use of measures of aggression that have not been properly validated (Ferguson & Rueda, 2009; Ferguson, Smith, Miller-Stratton, Fritz, & Heinrich, 2008; Ritter & Eslea, 2005; Tedeschi & Quigley, 1996). The issue of the real-world implications of findings from laboratory studies is further complicated by the fact that they can only investigate short-term effects that often only last for a few minutes (Barlett, Branch, Rodeheffer, & Harris, 2009). Cross-sectional correlational research, on the other hand, typically has larger samples, but is unsuitable for making any claims about the direction of the effect. Longitudinal studies combine the advantages of cross-sectional and experimental studies, as they use larger samples than most experimental studies and allow to sort out the temporal precedence between the variables of interest. Although it is still possible that additional variables are responsible for the temporal order, given a sound control of potentially relevant third variables, panel studies allow to make claims about long-term effects that both cross-sectional and experimental research do not allow. Nonetheless, while panel data can help to determine direction and strengths of effects by testing for covariation and controlling for temporal order, only controlled experiments provide the means to actually prove causality (Finkel, 1995).

Compared with the abundance of cross-sectional survey studies and experimental research, panel studies on video games and aggression are still scarce. The meta-analysis by Anderson et al. (2010), for example, included 34 effect sizes from longitudinal studies[2] and Ferguson and Kilburn (2009) used data from five longitudinal studies. While several longitudinal studies use a composite score for media violence that includes video games (e.g., Ferguson, Ivory, & Beaver, 2013; Gentile, Coyne, & Walsh, 2011; Krahé, Busching, & Möller, 2012; Krahé & Möller, 2010; Ostrov, Gentile, & Crick, 2006), there are relatively few that look specifically at the effects of video games. Among those studies that explicitly investigate video games, some only look at relatively brief periods of several months, and almost all studies rely on convenience samples and focus on children or adolescents. In longitudinal research on media violence and aggression, there are two seemingly competing hypotheses. The socialization hypothesis states that the repeated use of violent media leads to an increase of aggression over time, whereas the selection hypothesis is based on the idea of selective exposure (Zillmann & Bryant, 1985) and posits that individuals who are more aggressive will tend to choose (more) violent media content. The downward spiral model (Slater, Henry, Swaim, & Anderson, 2003) combines these hypotheses by proposing that individuals higher in trait aggression will choose more violent media content, which, in turn, increases their level of aggression. As with the experimental and cross-sectional studies, evidence from longitudinal studies on the relationship between (violent) video games and aggression is mixed at best. Some studies found a media effect (Anderson et al., 2008; Hopf, Huber, & Weiß, 2008; Möller & Krahé, 2009), while others report selection effects (von Salisch, Vogelgesang, Kristen, & Oppl, 2011), provide evidence for both (Slater et al., 2003), or found no effects (Ferguson, 2011; Ferguson, Garza, Jerabeck, Ramos, & Galindo, 2013; Ferguson, San Miguel, Garza, & Jerabeck, 2012; Wallenius & Punamäki, 2008; Williams & Skoric, 2005).

A limitation of the previous longitudinal studies is that almost all of them rely on convenience samples that are mostly composed of students from elementary schools, high schools, or colleges located in the areas where the respective researchers are based. Most studies also focus on specific grades, thereby reducing the age range of participants. In addition, even longitudinal studies often only test one direction of effects; mostly the socialization hypothesis. The goal of the current study was to address

[2] Anderson et al. (2010) do not report the number longitudinal studies in their paper. This number should substantially lower than the number of effect sizes, as most longitudinal studies include cross-sectional and longitudinal effects (often also for different dependent variables).

some of these issues by testing both the socialization and the selection hypothesis and comparing these relationships for adolescents and young adults, as these groups differ with regard to their developmental stage as well as their access to (violent) video games.

**Theories Explaining Long-Term Effects of Video Games on Aggression**

In the field of media violence research, there are three comprehensive theoretical models that aim at explaining the relationship between violent video games and aggression. The most popular is the General Aggression Model (GAM; Anderson & Bushman, 2002). The GAM combines the assumptions of social learning (Bandura, 1977), excitation transfer (Zillmann,1983), and cognitive neoassociation (Berkowitz, 1990). Long-term effects of video game violence are explained mainly by mechanisms of social learning and cognitive neoassociation. Put briefly, the GAM posits that the repeated use of violent media causes a learning, rehearsal, and reinforcement of aggressive beliefs, attitudes, perceptual and expectation schemata, and behavioral scripts, as well as an emotional desensitization to violence. In their combination, all of these processes can lead to an increase in aggressive personality and, ultimately, affect the likelihood to (re-) act aggressively in social encounters in the real world.

Although the GAM allows to formulate specific hypotheses about the effects of violent video games and has been widely used in previous research, it has been criticized for its overreliance on social learning, the neglect of biological factors, the conceptualization of media use(r)s as passive, and the insufficient distinction between real and fictional violence (Ferguson & Dyck, 2012). An alternative theory that focuses more on genetic factors and attributes of the social environment is the Catalyst Model (Ferguson et al., 2008). In essence, the Catalyst Model suggests that the roots of (violent) criminal and aggressive behavior are genetic and proximal social factors, such as family and peer influences, and their interaction, whereas distal social influences, such as media violence, only have a negligible effect (Ferguson, Ivory, et al., 2013). In this model, violent media are considered as stylistic catalysts instead of sources of aggression. This means that individuals with an increased tendency for aggressive behavior may model violent acts they have seen in the media, whereas the actual inclination to (re-) act aggressively is not influenced or caused by violent media. The main limitation of the Catalyst Model is that it is difficult to test, as the measurement of genetic and proximal social risk factors poses substantial challenges to the methods of social science research. To date only three studies have systematically tested the Catalyst Model and found support for its main assumptions (Ferguson, Ivory, et al., 2013; Ferguson et al., 2008; Surette, 2013).

The Downward Spiral Model by Slater et al. (2003) is a theory that accounts for both the socialization and the selection hypothesis. The Downward Spiral Model has also been called the negative feedback loop model by its authors (Slater, 2003) and describes a reciprocal reinforcement of aggressive personality and preference for violent media content. Basically, the model assumes a circular relationship between current and future aggressive tendencies and use of violent media. While the inclusion of both socialization and selection effects is a strength of this model, it does not make any detailed statements about the role of other variables, such as personal experiences with violence, that could potentially moderate the relationship between media use and aggression. As the downward spiral can only be studied in longitudinal designs that ideally also include more than two waves, there have been few studies that actually tested this model (Ferguson, 2011; Möller & Krahé, 2009; Slater et al., 2003; von Salisch et al., 2011; Willoughby, Adachi, & Good, 2012) and only one of these studies provided some empirical support for it (Slater et al., 2003).

**Longitudinal Studies on Video Games and Aggression**

As mentioned before, the number of longitudinal studies on video games and aggression is still relatively small. As the present study was concerned with video games, the overview in this section will focus on studies that were published in peer-reviewed journals and explicitly looked at the relationship between aggression and video games, and not violent media content in general. One of the earliest studies focusing on video games was the short-term longitudinal field study by Williams and Skoric (2005). This study investigated the effect of one particular massively multiplayer online role-playing game (MMORPG) on aggressive cognitions and behaviors. Later studies looked at longer periods (typically between 1 and 2 years) and video games in general or at least specific genres or types of games (mostly "violent" games; with varying definitions of what "violent" means). In our review of the literature, we found 11 journal publications that present longitudinal data from studies dealing specifically with the relationship of aggression and video games. Table 1 sums up their methods (sample, design, and measures) and main findings. Overall, there are vast differences between these studies with regard to both the direction (socialization vs. selection) and the size of the effects they found. A big part of the inconsistencies in the results can be attributed to major methodological discrepancies between the individual studies. The longitudinal studies differ from one another in various respects, including size, origin, and composition of the sample; measures of aggression and exposure to violent video games; control variables; and number of and time lag between waves (Table 1). While the differences in some crucial categories, such as the measures for aggression and exposure to violent content, are quite substantial, other features are much more homogeneous across studies. Although sample sizes vary between N = 143 (Ferguson, Garza, et al., 2013; Möller & Krahé, 2009) and N = 1,492 (Willoughby et al., 2012), almost all of them are convenience samples and the large majority include only children and/or adolescents (Table 1). Summing up the comparisons in Table 1, it can be noted that both the methods and results of longitudinal studies on the link between aggression and video game use are very heterogeneous. This heterogeneity of findings and measures is somewhat contrasted by a relative homogeneity in the age and recruitment of the samples.

**Aggression, Violent Video Games, and Age**

Our review of previous longitudinal studies on video games and aggression revealed that the majority of them worked with convenience samples of children and teenagers, with the exception of the study by Williams and Skoric (2005) that used a self-selected online sample that also included adult players. Accordingly, the age range of the samples typically only spans a few years (M = 4.8 years for the nine studies in Table 1 that report the age range of their sample). Due to the limited age range of most studies, few of them have investigated the role of participant age in detail. While controlling for participant sex is done in most studies, only a few control for age (Wallenius & Punamäki, 2008; Williams & Skoric, 2005) or specifically look at potential differences in the size and direction of effects between age groups (Anderson et al., 2008; Ferguson, Garza, et al., 2013; Willoughby et al., 2012).[3] Most of the studies that did compare between age groups also found differences in terms of effect size. In the study by Willoughby et al. (2012), there were only small socialization effects from grades 9 to 10 ($\beta$ = .06) and 11 to 12 ($\beta$ = .08), but not from grades 10 to 11, when controlling for all of the measured third variables. Anderson et al. (2008) found stronger socialization effects for the younger samples ($\beta$ = .15) than for the older sample ($\beta$ = .08). However, the study by Ferguson, Garza, et al. (2013) that found no effect of exposure to video game violence on aggression, bullying, and delinquency also found no differences between the groups of late childhood (ages 10-11), preadolescence (12-13), and adolescence (14-17). With regard to age differences, von Salisch et al. (2011) suggest that the selection effect they found in their study with third and fourth graders may be replaced by socialization effects once media preferences have become more stable at an older age.

In a review of the literature on violent video games and aggression, Kirsh (2003) laments the absence of a developmental perspective. For the case of video game violence and aggression, this is especially problematic, as research has shown that video game preferences differ between age groups and also change over time (Greenberg, Sherry, Lachlan, Luca, & Holmstrom, 2010). Genres that typically include large amounts of violence, such as action and

[3] While Willoughby et al. (2012) compared the effect sizes across three waves for the same sample, Anderson al. (2010) calculated a combined model that distinguished between younger and older participants with the data from the two Japanese studies and the one American study.

Table 1
Overview of Longitudinal Studies on Video Games and Aggression

| Study | Country | Sample | Sample type | Measure of video game violence | Measure(s) of aggression | Control variables | Waves | Time lag between waves | Socialization effect | Selection effect |
|---|---|---|---|---|---|---|---|---|---|---|
| Williams & Skoric (2005) | USA | N = 213; Age 14-68 (M = 27.7) | Self-selected | Self-reported hours of play for MMORPG Asheron's Call 2 | Normative Beliefs in Aggression general scale (Huesmann & Guerra, 1997); two behavioral questions on aggressive social interactions | Sex, age | 2 | 1 month | Normative beliefs about aggression: B = .25, n.s.; Arguments with friends: B = -1.63, n. s.; Arguments with partner: B = -.04, n.s. | Not tested (field study) |
| Wallenius & Punamäki (2008) | Finland | N = 316; Age (T2) 12-15 (M = 13.8) | Convenience | Self-reported ratings of violence in games played and frequency of playing action, fighting, and shooting games | Ten items from the Direct & Indirect Aggression Scale (Björkqvist, Lagerspetz, & Österman,1998) | Sex, age-group, parent-child communication | 2 | 2 years | $\beta$ = .01, n.s. | Not tested |

(table continues)

Table 1 (continued)

| Study | Country | Sample | Sample type | Measure of video game violence | Measure(s) of aggression | Control variables | Waves | Time lag between waves | Socialization effect | Selection effect |
|---|---|---|---|---|---|---|---|---|---|---|
| Shibuya et al. (2008) | Japan | N = 591; Age (T1) 10-11 (mean age not reported) | Unclear(most likely convenience) | Dichotomous variable (violent yes/no) for three favorite video games and 21 contextual variables about the type of violent content in each game | Aggression Scale for Children (Buss & Perry,1992; Sakai et al., 2000); anti-violence norms; recent aggressive behavior | Sex, area of living, weekly video game use | 2 | 1 year | Hostility: ($\beta$ =.13, $p < .05$ for boys and n.s. for girls; Physical and verbal aggression, antiviolence norms, and aggressive behavior: all n.s. for both girls and boys (effect sizes not reported) | Not tested |
| Hopf et al. (2008) | Germany | N = 314; Mean age (T1 = 12) | Convenience | Frequency of playing violent games from a list of 19 popular titles | Items on violence beliefs, delinquency, verbal aggression, physical aggression, and deviance in school (Tillmann, Holler-Novitzki, Holtappels, Meier, & Popp, 1999) | School and classroom climate, well-being in school, self-regulation, self-efficacy in school, emotional reactions to violence, materialistic value orientations, media education by parents, poverty, aggressiveness, peaceableness | 2 | 2 years | Aggressive behavior in school: $\beta$ = .18 (significance level not reported); Delinquency: $\beta$ = .29 (significance level not reported) | Not tested |

(Table continues)

Table 1 (continued)

| Study | Country | Sample | Sample type | Measure of video game violence | Measure(s) of aggression | Control variables | Waves | Time lag between waves | Socialization effect | Selection effect |
|---|---|---|---|---|---|---|---|---|---|---|
| Anderson et al. (2008) | USA | N = 364; Age 9-12 (mean age not reported) | Unclear(most likely convenience) | Self-reported amount of violent content X frequency of play for three favorite video games | Index of teacher, peer, and self-reports of physical aggression | Sex, physical aggression at time 1 | 2 | 5 to 6 months | β = .16 (95%-CI: .08, .23) | Not tested |
| | Japan | N = 181; Age 12-15 (mean age not reported) | Unclear(most likely convenience) | Frequency of playing five violent video genres: fighting action, action, action role-playing, shooting, adventure | Six-item version of the physical aggression scale by Buss & Perry (1992) | Sex, physical aggression at time 1 | 2 | 4 months | β = .14 (95%-CI: .03, .25) | Not tested |

(Table continues)

Table 1 (continued)

| Study | Country | Sample | Sample type | Measure of video game violence | Measure(s) of aggression | Control variables | Waves | Time lag between waves | Socialization effect | Selection effect |
|---|---|---|---|---|---|---|---|---|---|---|
| | Japan | N = 1,050; Age 13-18 (mean age not reported) | Unclear(most likely convenience) | Video game play in hrs per week X violence ratings for most favorite genre and three additional favorite genres assigned by the authors | Single item self-report on frequency of physical aggression in the last month | Sex, physical aggression at time 1 | 2 | 3 to 4 months | β = .08 (95%-CI: .02, .13) | Not tested |
| Möller & Krahé (2009) | Germany | N = 143; Mean age (T1) = 13.3 | Convenience | Frequency of play X expert violence ratings for a list of popular games | Seven items from the physical aggression subscale by Buss & Perry (1992) + seven items on relational aggression based on the indirect aggression scale by Buss & Warren (2000) | Sex, normative beliefs about aggression, hostile attribution bias | 2 | 30 months | Physical aggression: β = .27, $p < .001$; Relational aggression: β = .08, n.s. | Physical aggression: β = -.02, n.s.; Relational aggression: β = -.09, n.s. |

(Table continues)

Table 1 (continued)

| Study | Country | Sample | Sample type | Measure of video game violence | Measure(s) of aggression | Control variables | Waves | Time lag between waves | Socialization effect | Selection effect |
|---|---|---|---|---|---|---|---|---|---|---|
| Ferguson (2011) | USA | N = 302; Age (T1) 10-14 (M = 12.3) | Convenience (snowball sampling) | ESRB ratings X frequency of play for three favorite video games | Child Behavior Checklist (Achenbach & Rescorla, 2001) filled out by the participants and their primary caregivers; Olweus Bullying Questionnaire (Olweus, 1996); general delinquency subscale of the Negative Life Events questionnaire (Paternoster & Mazerolle, 1994) | Sex, antisocial personality, neighborhood problems, negative relations with adults, family attachment, delinquent peers family environment, family violence depressive symptoms | 2 | 1 year | Self-reported serious aggression: $\beta = .-03$, n.s.; Other-reported serious aggression: $\beta = -.01$, n.s.; Violent crime: $\beta = .07$, n.s.; Bullying: $\beta = .12$, n.s.; | n.s. (effect size for aggressive behavior not reported) |
| von Salisch et al. (2011) | Germany | N = 324; Age (T1) 8-12 (M = 8.9) | Convenience | Average of expert violence ratings for up to six favorite computer or video games | Peer and teacher nominations for verbally and physically aggressive behavior | Sex, neighborhood of residence, parents' migration status, presence of an older brother, school achievement, self-perceived competence | 2 | 1 year | $\beta = -.01$, n.s | $\beta = .26$, $p < .01$ |

(Table continues)

Table 1 (continued)

| Study | Country | Sample | Sample type | Measure of video game violence | Measure(s) of aggression | Control variables | Waves | Time lag between waves | Socialization effect | Selection effect |
|---|---|---|---|---|---|---|---|---|---|---|
| Willoughby et al. (2012) | Canada | N = 1,492; Age not reported (T1: Canadian ninth-graders) | Complete sample of all high schools in one school district in Ontario, Canada | Dichotomous variables (yes/no) for action and fighting video games (sustained play: sums for all waves) & frequency of playing action and fighting games for grades 11 and 12 | Overt aggression assessed by a composite of two scales (Little, Jones, Henrich, & Hawley, 2003; Marini, Spear, & Bombay, 1999) | Sex, nonviolent video game play, academic marks, depressive symptoms, delay of gratification, peer deviance, sports involvement, friendship quality, parent-adolescent relationship quality, parental control, school culture | 4 | 1 year | Grades 9-10: $\beta = .06$, $p < .05$; Grades 11-12: $\beta = .08$, $p < .01$ | βs not reported, but all n.s. |
| Ferguson et al. (2012) | USA | N = 165; Age (T1) 10-14 (M = 12.3) | Convenience | ESRB ratings X frequency of play for three favorite video games | Child Behavior Checklist (Achenbach & Rescorla, 2001) filled out by the participants and their primary caregivers | Sex, antisocial personality traits, family attachment, delinquent peers, family violence, depression | 3 | 1 year and 2 years | Self-reported serious aggression: $\beta = .03$, n.s.; Other-reported serious aggression: $\beta = -.03$, n.s.; Dating violence: $\beta = -.05$, n.s.; | Not tested |

(Table continues)

Table 1 (continued)

| Study | Country | Sample | Sample type | Measure of video game violence | Measure(s) of aggression | Control variables | Waves | Time lag between waves | Socialization effect | Selection effect |
|---|---|---|---|---|---|---|---|---|---|---|
| Ferguson, Garza, et al. (2013) | USA | N = 143; Age (T1) 10-17 (M = 12.8) | Convenience | ESRB ratings X frequency of play for three favorite video games | Child Behavior Checklist (Achenbach & Rescorla, 2001) filled out by the participants' primary caregivers; Olweus Bullying Questionnaire (Olweus, 1996); general delinquency subscale of the Negative Life Events questionnaire (Paternoster & Mazerolle, 1994) | Sex, depressive symptoms, antisocial personality, family attachment, delinquent peers, parental supervision, parental depression | 2 | 1 year | Aggression: $\beta$ = -.02, n.s.; Delinquency: $\beta$ = .02, n.s.; Bullying: $\beta$ = .05, n.s. | Not tested |

Note. ESRB = Entertainment Software Rating Board.

first-person shooter games, are particularly popular among younger players (Quandt, Breuer, Festl, & Scharkow, 2013). At the same time, the age of a player also affects her or his access to video games. Most games that feature very explicit and graphical depictions of violence are rated 18+ and should, hence, not be legally available to minors. Teenage players usually also have a very limited amount of personal income that they can spend on video games, and parents are more likely to monitor the media use of their children when they are younger (Wallenius & Punamäki, 2008). But, age not only determines the accessibility and use of violent video games, it is also related to (physical) aggression. Developmental researchers found a curvilinear relationship between aggression and age, with peaks in early adolescence (Lindeman, Harakka, & Keltikangas-Järvinen, 1997; Loeber & Stouthamer-Loeber, 1998). Willoughby et al. (2012) also suggest that "the long-term relation between violent video game play and aggression may be different for adolescents (e.g., 12 to 19 years) and adults (e.g., 25 years and older), due to changes in the brain during adolescence and young adulthood" (p.12). Following this suggestion, the present study was carried out to investigate whether the size and maybe even the direction of effects differ for adolescents and young adults. Adolescents and young adults are an interesting target demographic for this line of research because they have been shown to be the heavy users of video games (Greenberg et al., 2010). A recent survey among adolescents aged 12 to 19 in Germany showed that 81% play video games and that 34% regularly play games with violent content (Medienpädagogischer Forschungsverbund Südwest, 2012).

## Method

### Participants and Procedure

Our review of the existing literature showed that most studies rely on convenience samples (Table 1), typically drawn from local schools. Only the study by Willoughby et al. (2012) can be seen as potentially representative, at least for high school students in the province of Ontario, Canada. To arrive at more generalizable results, our study used data from a representative panel study of German gamers aged 14 and older. Recruiting for this study was a two-step procedure. First, a representative sample of 50,012 persons aged 14 and older were asked about their use of video games in an omnibus telephone survey. This sample was recruited in accordance with the German Arbeitskreis Deutscher Markt- und Sozialforschungsinstitute (ADM) telephone sampling system (von der Heyde, 2013): First, private households with phones (mostly landline plus a small amount of mobile phone numbers) were selected randomly. Second, within the household, the individual whose last birthday was closest to the date of the call was selected for the telephone interview. Approximately 25% (N 12,587) of the participants were identified as gamers (i.e., individuals who currently play video games at least occasionally). From this group, we recruited a stratified random sample of 4,500 gamers for the first wave of the main study. This sample was composed of 3,500 respondents who play digital games with others (colocated, online, or via local networks) and 1,000 gamers who only play solo. Due to this stratified sampling, the proportion of gamers who play with others was higher in the main study (77.8%) than in the omnibus survey (68.4%). The computer-assisted telephone interviews were conducted by a professional German market research institute. At the end of the interview, respondents were asked, if they were willing to participate in the second wave of the study 1 year later. Because of financial constraints and in anticipation of panel mortality, we recruited a random subset of about 50% of the respondents from wave 1 of the main study for the second wave. Thus, of the 4,500 gamers from wave 1, N = 2,199 were interviewed in wave 2. As we were only interested in the longitudinal relationship of violent video games and aggression among adolescents and young adults, we focused our analysis on those respondents who participated in both waves and were aged 14 to 21 when they were first interviewed. This subsample included n = 332 individuals. There was no difference in average age between respondents who took part in both waves and those who were interviewed only in the first wave ($M_2$ = 17.5 years compared with M1 =17.7, t(883) = 1.15, p = .25). The second wave sample contained slightly more females than the first wave sample (29% compared with 26%, $\chi^2(1) = 0.74$, p = .39). After listwise deletion, the final sample (see Data Analysis section) comprised n = 276 respondents (i.e., 83% of the subsample).[4] Little's (1988) likelihood ratio test showed ($\chi^2(18) = 23.32$, $p = .18$) that the missing data of the variables of interest (physical aggression and use of violent video games) are missing completely at random. Respondents of the final sample that was used for our analyses had an average age of 17.6 (SD = 1.9) and 19.2% (n = 53) of them were female.

**Measures**

**Demographic factors.** Participant sex, age, and education were all measured with single items. The education item asked respondents about their highest educational degree. The answering option reflected the German educational system and ranged from 0 (no school leaving certificate) to 5 (university degree).

**Physical aggression.** We decided to focus on physical aggression, as this is the type of aggression most commonly featured in violent video games (Lachlan, Smith, & Tamborini, 2005; Smith, Lachlan, & Tamborini, 2003) and both socialization and selection effects are more likely to occur, if the behavior presented in the game and the one exhibited in real life are similar (Möller & Krahé, 2009). We used two items from the German translation (Herzberg, 2003) of the physical aggression subscale from the Aggression Questionnaire by Buss and Perry (1992). The two items were "There are people who pushed me so far that we came to blows" (phys aggr 1) and "Given enough provocation, I may hit another person" (phys aggr 2). Participants indicated on a 5-point scale to what degree these statements apply to them (ranging from 1 does not apply at all to 5 = fully applies). Cronbach's alphas for physical aggression were satisfactory and stable across both waves for the subsample under investigation (t1: $\alpha = .75$; t2: $\alpha = .74$).

**Use of violent video games.** Participants were asked to name their favorite game plus up to five additional games that they currently play. All games were then coded for the age rating assigned by the German age rating system Unterhaltungssoftware Selbstkontrolle (USK) using their online database (see www.usk.de/en). The coding scheme used the USK age rating system (0, 6, 12, 16, 18) with the additional category of "no clearance." No clearance means that the game did not receive an official age rating from the USK because it is deemed harmful to minors. In such cases, the games are examined by the Federal Review Board for Media Harmful to Minors (BPjM: Bundesprüfstelle für jugendgefährdende Medien; see http://www.bundespruefstelle.de/bpjm/information-in-english.html). If the BPjM arrives at the decision that a video game is potentially harmful to minors, the game is not allowed to be advertised in Germany and can only be sold "under the counter" in stores to which minors have access. Eventually, this means that the game is less publicly visible and much harder to (legally) acquire, but it might also increase its appeal as a "forbidden fruit" (Bijvank, Konijn, Bushman, & Roelofsma, 2009).

For each wave, we computed a mean age rating score for every participant who named at least one game. We used the USK rating as an indicator for violent content, as this characteristic is one of the main reasons for the assignment of age ratings in Germany (Hyman, 2005; MacMillan & Wedell, 2013). If games are not given an age rating, this is mostly due to extreme and explicit depictions of violence (see http://www.usk.de/fileadmin/documents/USK_Broschuere_ENG.pdf). Previous content analyses have also shown that games with higher age ratings tend to include more frequent and more graphic portrayals of violence (Haninger & Thompson, 2004; Thompson, Tepichin, & Haninger, 2006). Age ratings have already been used as a proxy for violent content in several previous studies (Ferguson, 2011; Ferguson et al., 2012; Olson et al., 2009) and they were clearly correlated with ratings of violent content in the studies by Busching et al. (2013); Möller and Krahé (2009), and Ferguson (2011). While Busching et al. (2013) suggest that age ratings are valid and reliable measures of violent content, they caution researchers that "they should only be used in the country in which they were

[4] The relatively high number of excluded respondents is mostly due to missing values in the age ratings for the games they played (details see Measures section). In several cases, the games could not be clearly identified because of unintelligible answers by the respondents or typos by the interviewers or because there were no age ratings available for the game in the USK database (e.g., for games played over social networking sites).

developed” (p. 13) because of potential intercultural differences in the reasons for assigning age labels. Overall video game use. Overall use of video games was measured in self-reported hours per day.

### Data Analysis

For our main analysis, we performed parameter estimation using the mean- and variance-adjusted maximum likelihood (MLMV) procedure in Mplus (Version 6.0; Muthén & Muthén,1998-2010). MLMV provides chi-square values and estimates with standard errors that are robust to non-normality. Model fit is assessed using the probability of the mean- and variance-adjusted chi-square value ($p \geq .05$), root-mean square error of approximation (RMSEA ≤ .06), the comparative fit index (CFI ≥ .9), and weighted root mean square residual (WRMR ≥ .9). Model comparison and selection was performed using MLMV difference testing (Asparouhov & Muthén, 2006). For the comparison of age groups, we distinguished between adolescents (aged 14-17 at $t_1$) and young adults (18-21 at $t_1$). The age of 18 was chosen as a cutoff because this is the age at which you can legally buy video games that are labeled 18+,which is the highest age rating assigned by the German USK (see previous section on Measures). We opted for a group comparison instead of using age as a continuous control variable because we were interested more in the differences between the two populations of adolescents and young adults and less in the influence of age on physical aggression and the use of (violent) video games.

## Results

### Preliminary Analyses

Table 2 shows the intercorrelations of the variables included in the structural equation model as well as their means, standard deviations, skewness, and kurtosis.
As the descriptive statistics for the two age groups differed, we examined mean differences in the measures of video game use and physical aggression. Although the mean differences were in the expected directions, with older respondents (18-21) playing more violent games ($M = 2.85$), while reporting fewer hours of overall video game play ($M = 1.17$) and lower levels of mean physical aggression ($M = 1.77$) than the respondents aged 14 to 17 (Ms = 2.65; 1.24; 1.97), separate t-tests revealed no significant differences between the groups at Time 1 (all $p > .1$, $r < .1$).[5] Although the differences between the groups were not significant, they mirror the descriptive data from the Jugend, Information, (Multi-) Media (JIM) study of adolescents and media use in Germany that found a decrease of overall gaming frequency, but an increase in the use of violent games with age (Medienpädagogischer Forschungsverbund Südwest, 2012). Looking at the cross-sectional association between the use of violent games and physical aggression, we found a significant correlation only for the younger group ($r = .34$, $p < .001$).[6]

### Long-Term Relationships Between Use of Violent Video Games and Physical Aggression

Longitudinal research rests on the assumption that the meaning of the constructs involved does not change over time. To test this, the factor loadings of the measurement model were constrained to be time-invariant over the two waves. The overall model fit indicates that the validity of the physical aggression measurement model does not change over time ($\chi^2(6, N = 276) = 12.39$, $p = .05$, CFI = .98, RMSEA = .06, WRMR = .62). In the next step, we further tested the assumption that the physical aggression measurement model is group-invariant (i.e., the validity of physical aggression measurement model is the same for individuals aged 14-17 years and 18-21 years). The overall model fit indicates that this assumption is valid ($\chi^2(15, N_{14\text{-}17} = 140, N_{18\text{-}21} = 136) = 17.92$,

[5] We refrained from comparisons between female and male respondents due to their uneven distribution in our sample. Most of the previous studies, however, have found males to report higher levels of both aggression and use of violent video games (e.g., Anderson et al., 2008; Ferguson, Garza, et al., 2013; Möller & Krahé, 2009; Shibuya et al., 2008; von Salisch et al., 2011; Wallenius & Punamäki, 2008; Willoughby et al., 2012).
[6] After controlling for measurement error in the cross-lagged structural equation model, the cross-sectional path turned out to be even stronger with $r = .4$ (see next section and Figure 1).

Table 2
Intercorrelations Between Items for Participants Aged 14 to 17 Years and 18 to 21 Years

| Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | | | Adolescents aged 14–17 years (n = 140) | | | | | | |
| 1. Phys aggr 1 $t_1$ | — | .56 | .58 | .52 | .31 | .29 | -.22 | -.15 | .01 |
| 2. Phys aggr 2 $t_1$ | | — | .49 | .55 | .29 | .37 | -.25 | -.0.9 | .07 |
| 3. Phys aggr 1$t_2$ | | | — | .62 | .13 | .27 | -.19 | -.16 | -.02 |
| 4. Phys aggr 2 $t_2$ | | | | — | .25 | .28 | -.27 | -.23 | -.08 |
| 5. Violent game use $t_1$ | | | | | — | .46 | -.33 | -.01 | 28 |
| 6. Violent game use $t_2$ | | | | | | — | -.34 | -.06 | .24 |
| 7. Participant sex $t_1^a$ | | | | | | | — | .03 | -.17 |
| 8. Education $t_1$ | | | | | | | | — | -.13 |
| 9. Gaming frequency $t_1$ | | | | | | | | | — |
| Mean | 1.86 | 2.08 | 1.58 | 1.41 | | 2.63 | .22 | 2.85 | 1.24 |
| SD | 1.24 | 1.25 | .98 | .70 | 1.26 | 1.26 | .42 | 1.12 | 1.29 |
| Skewness | 1.33 | 1.16 | 1.86 | 1.91 | .22 | .27 | 1.36 | -12 | 2.16 |
| Kurtosis | .62 | .39 | 3.02 | 4.52 | -1.14 | -.98 | -.16 | -1.62 | 6.30 |
| | | | Young adults aged 18–21 years (n = 136) | | | | | | |
| 1. Phys aggr 1 $t_1$ | — | .64 | .59 | .54 | .03 | -.04 | -.15 | -.04 | .08 |
| 2. 1. Phys aggr 2 $t_1$ | | — | .64 | .53 | .02 | -.01 | -.21 | -.08 | .08 |
| 3. 1. Phys aggr 1 $t_2$ | | | — | .65 | .08 | .07 | -.21 | -.05 | .09 |
| 4. 1. Phys aggr 2 $t_2$ | | | | — | .10 | .06 | -.21 | .01 | .24 |
| 5. Violent game use $t_1$ | | | | | — | .65 | -.21 | -.06 | .17 |
| 6. Violent game use $t_2$ | | | | | | — | -.21 | -.05 | .25 |
| 7. Participant sex $t_1^a$ | | | | | | | — | .06 | -.19 |
| 8. Education $t_1$ | | | | | | | | — | .05 |
| 9. Gaming frequency $t_1$ | | | | | | | | | — |
| Mean | 1.68 | 1.85 | 1.56 | 1.41 | 2.85 | 2.63 | .16 | 3.41 | 1.17 |
| SD | 1.10 | 1.13 | .97 | .75 | 1.19 | 1.22 | .37 | .95 | 1..11 |
| Skewness | 1.77 | 1.36 | 1.97 | 2.19 | -.04 | .16 | 1.86 | -1.15 | 1.25 |
| Kurtosis | 2.42 | .99 | 3.53 | 5.30 | -.91 | -.97 | 1.47 | -.08 | .84 |

Note. [a]0 = male, 1 = female.

p =.27, CFI = .99, RMSEA = .04, WRMR = .48). In sum, the aforementioned tests show that physical aggression has been measured time-and group-invariant.

Figure 1 shows the results of the cross-lagged structural equation model. The upper values of the arrows in Figure 1 represent the parameter estimates for the younger age-group (14-17), while the lower values show the parameter estimates for the older age-group (18-21). On the left side, the two-sided arrow shows the cross-sectional correlation between physical aggression and use of violent games. The horizontal one-sided arrows between the same variables represent the stability estimates (autoregression). The standardized autoregression coefficient is a number between -1 and +1. A high positive value indicates that interindividual differences over time do not change, which is commonly referred to as covariance stability. The one-sided arrows between different variables represent the cross-lagged effects. The two-sided arrow on the right side of Figure 1 shows the cross-sectional residual correlation of the dependent variables after controlling for autoregressive and cross-lagged effects.

Parameter estimation suggests that physical aggression self-reports were highly stable over time. A $\chi^2$-difference test indicated that the autoregressive effects of physical aggression are not statistically different between the two groups ($\Delta\chi^2(1, N_{14-17} =140, N_{18-21} = 136) = 1.01$, $p = .32$, one-tailed). It can therefore be concluded that physical aggression is highly time-invariant in both groups. By contrast, the two age groups differ with respect to the autoregression of violent game use ($\Delta\chi^2(1, N_{14-17} = 140, N_{18-21} = 136) = 8.96$, $p < .01$, one-tailed). The use of violent video games is far more stable among respondents aged 18 to 21.

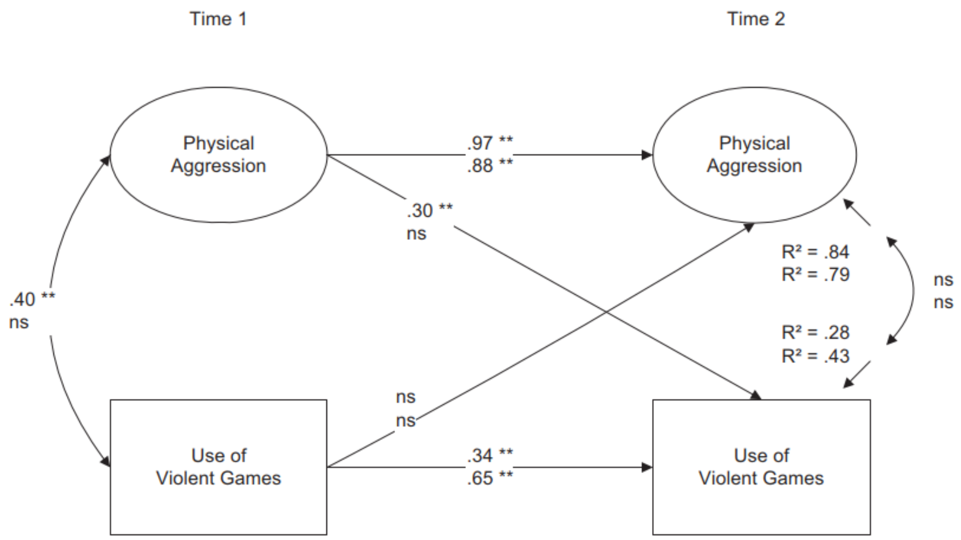


Figure 1. Cross-lagged structural equation model: Relationships between physical aggression and use of violent games. Note. Upper row: standardized coefficients of adolescents aged 14 to 17 years, lower row: standardized coefficients of young adults aged 18 to 21 years. N = 276, MLMV estimation, $\chi^2$(15, N14-17 = 140, N18-21 = 136) = 17.92, p = .27, CFI = .99, RMSEA = .04, WRMR = .48, * p ≤ .05, ** p ≤ .01.

The cross-sectional positive correlation between physical aggression and violent video game use is statistically significant (r = .40, $p < .01$, one-tailed) for the younger group. However, this contemporary correlation only indicates covariation. To test the temporal order, cross-lagged parameters were estimated. Comparing all cross-lagged effects showed that only one parameter estimate between physical aggression self-reports at Time 1 and the use of violent games at Time 2 was statistically significant. Participants aged 14 to 17 who are more physically aggressive at Time 1 nominated more violent games at Time 2 ($\beta$ = .30, $p < .01$). By contrast, this relationship was not found for young adults (aged 18-21). A $\chi^2$-difference test proved that the effect size difference between the two groups was statistically significant (A$\chi^2$(1, $N_{14\text{-}17}$ = 140, $N_{18\text{-}21}$ = 136) = 8.04, p <.01, one-tailed). Accordingly, our data suggest that physical aggression predicts the use of violent video game among adolescents, while the reverse does not seem to be true. The cross-lagged structural equation model depicted in Figure 1 is only testing the bivariate relationship between physical aggression and violent video game use. It is important, though, to control for spurious effects of third variables on the bivariate relationship of interest (Slater, 2007). Following the procedure by von Salisch et al. (2011), we estimated three additional models. In each model, a third variable was introduced in the structural equations (Figure 2). The candidate set of third variables consisted of participant sex, level of education, and gaming frequency measured at Time 1. As can be seen in Table 3, all three additional two-group models fitted the data excellent. All $\chi^2$ tests were nonsignificant. When controlling for sex, level of education, and gaming frequency separately, physical aggression at Time 1 was still a significant predictor of violent video game use at Time 2 in the younger age-group. The selection effect varied between $\beta$ = .26 ($p < .01$) and $\beta$ = .34 ($p < .01$). The size of the cross-lagged socialization effects was again not statistically significant in any of the additional models. In sum, the longitudinal relations between physical aggression and violent video game use were not influenced by sex, education, or gaming frequency.

**Discussion**

The results of our study provide some evidence for a selection effect in the adolescent group aged 14 to 17. Essentially, this corroborates the findings from von Salisch et al. (2011), who found a selection effect in their

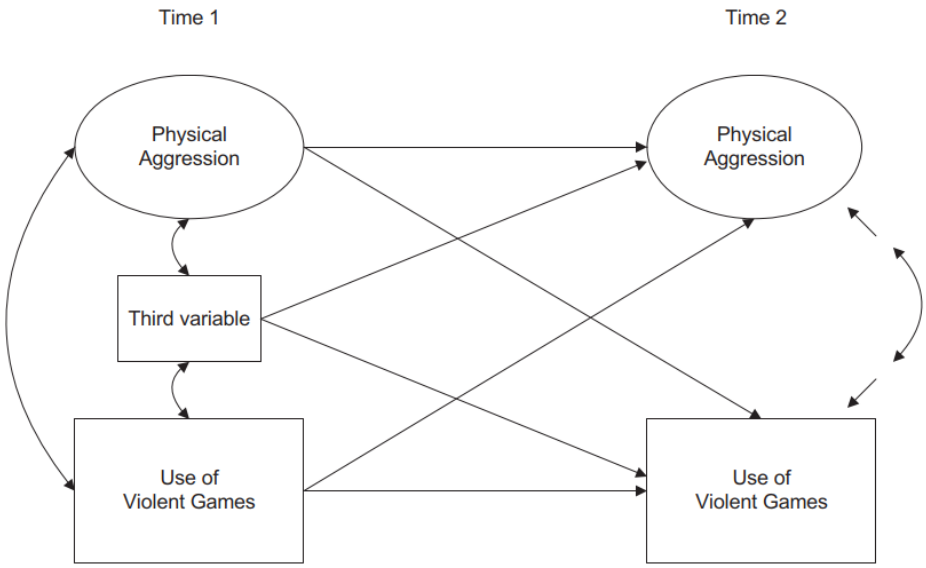


Figure 2. Cross-lagged structural equation model with third variable control.

sample of children aged 8 to 12, for an older sample. For the group of young adults aged 18 to 21, however, we found no indication of either a socialization or a selection effect. These findings pertain, even when controlling for participant sex, education, and overall frequency of video game play. This is in line with several previous longitudinal studies (Ferguson, Garza, et al., 2013; Ferguson et al., 2012; von Salisch et al., 2011; Wallenius & Punamäki, 2008; Williams & Skoric, 2005), while it also contradicts others (Anderson et al., 2008; Möller & Krahé, 2009).

With regard to the theories that explain the relationship between violent video games and aggression, our results fit best with the Catalyst Model (Ferguson et al., 2008) that does not predict a substantial influence of violent media on real-life aggression. The idea of violent media as a stylistic catalyst for individuals with a tendency for aggression is compatible with the selection effect we found for adolescents aged 14 to 17. The absence of socialization effects in the present study contradicts the assumptions of the GAM (Anderson & Bushman, 2002), according to which a repeated use of violent media leads to an increase in aggressive behavioral tendencies. While von Salisch et al. (2011) speculated that the selection effect they found for their sample of third and fourth graders might be the beginning of a downward spiral (Slater et al., 2003), our study found no such relationship for adolescents and young adults. As the sample in our study was limited to adolescents and young adults, however, it might be

Table 3
Influence of Third Variables on the Cross-Lagged Effects

| | Selection effect with third variable control | | Socialisation effect with third variable control | | Model fit | |
|---|---|---|---|---|---|---|
| | 14-17 | 18-21 | 14-17 | 18-21 | | |
| Third variable | β | β | β | β | $x^{(df)}$ | p |
| Participant sex (n = 276) | .26** | NS | NS | NS | 20.69 | .35 |
| Education (n = 247) | .34** | NS | NS | NS | 18.54 | .49 |
| Gaming frequency (n = 273) | .31** | NS | NS | NS | 23.38 | .22 |

Note. MLMV estimation.
*p ≤ .05. **p ≤ .01.

possible that socialization effects occur at a younger age when media preferences and especially personality traits are more malleable. As both physical aggression (Lindeman et al., 1997; Loeber & Stouthamer-Loeber, 1998) and the use of (violent) video games (Greenberg et al., 2010) change with age, it is not surprising that the same should be true for the relationship between these two variables. Both the peak in aggression and the height-ened interest in violent video games have been suggested to be part of normal (i.e., healthy) developmental phases, especially among boys (Ferguson, 2010; Lenhart et al., 2008; Olson, 2010). Accordingly, the selection effect we found for adolescents could be interpreted as a sign of selective exposure to violent content in a phase of life that goes along with a general peak in aggressive behavioral tendencies. It may well be that physical aggression, the use of violent games, and the selective exposure effect for adolescents can be explained by another underlying factor, such as sensation-seeking. Similar to the developmental change in aggression, a study by Steinberg et al. (2008) found a curvilinear relationship between age and sensation-seeking, with peaks between age 10 and 15. Previous studies have also linked sensation-seeking with both a preference for violent media (Slater, 2003) and aggression (Joireman, Anderson, & Strathman, 2003).

As stated before, some of the differences in the findings can be attributed to differences in the methods used. Unlike other studies that mostly relied on convenience samples, we used data from a representative sample of German gamers aged 14 and older. We also compared the effects for adolescents (aged 14-17) and young adults (18-21) to take into account both developmental change and the access to video games. The differences we found between the age groups suggest that age is an important variable that needs to be considered when investigating the relationship between aggression and video game use. From our data it appears that the selection effect disappears once media preferences have solidified and appeal of the “forbidden fruit” is diminished. The higher autoregression coefficient for the use of violent games among the older age-group ($\beta$ = .65 vs. $\beta$ = .34) indicates that video game preferences stabilize at the beginning of adulthood. It seems that the phase of preference formation that von Salisch et al. (2011) report for their sample of 8- to 12-year-olds continues into adolescence and begins to stabilize once players turn 18 and all types of games are legally available to them. In addition, parental control of video game use tends to decrease with age (Wallenius & Punamäki, 2008). This not only enables players to more freely choose the games they play, but likely also reduces the “forbidden fruit effect” (Bijvank et al., 2009).[7] Unfortunately, it is impossible to disentangle the effect of the solidification of media preferences and the forbidden fruit effect in our current data. Hence, to arrive at a more detailed understanding of what causes the disappearance of the selection effect in early adulthood, more research into the contribution and relationship of the factors of legal availability and the solidification of video game preferences would be necessary. For now, we can only assume that both contribute to some extent to the change in the relationship between video game use and (physical) aggression.

Physical aggression was extremely stable across waves for both age groups ($\beta$ = .97 vs. $\beta$ = .88). This stability of trait aggression in the transition from adolescence to early adulthood might be part of the reason why we found no media effects. Put simply, the use of violent video games cannot explain a change in physical aggression, if physical aggression does not change at all. Again, this is in line with the Catalyst Model (Ferguson et al., 2008), which proposes that the use of violent media is not a strong enough influence to alter fundamental personality traits. Genetic influences and proximal social factors, such as family violence (Ferguson, Ivory, et al., 2013; Ferguson et al., 2012), are likely to shape aggressive personality traits already before the later phases of adolescence that were the focus of the current study.

[7] Despite the relatively strict regulations in Germany, however, it is not uncommon for minors to play games that are not suitable for them according to the USK labels. In our wave 1 sample, 14% of gamers aged 14 and 15 played at least one game labeled 16+ and 29% reported to currently play at least one game with an 18+ USK rating. Of the respondents who were 16 or 17 years old in the first wave, 35% indicated that they play one or more games rated 18+.

Although we did cover a larger age range than most other longitudinal studies in this field and compared the relationship between violent video games and physical aggression for adolescents and young adults, our findings are not generalizable to other player populations, such as primary school students or older adults. Of course, our results do not mean that violent video games are completely harmless and do not have an effect on any player. Especially younger children may be negatively affected by these games, but then again, age rating systems and parental control should prevent access to violent games at a young age. Hence, if children play games that are not suitable for them, the undesired effects this may have are, ultimately, attributable to a lack of parent-child communication or parental care. The results may also be different for other countries. Germany has some of the strictest laws with regard to the protection of minors from potentially harmful media content. Some violent games are only available as localized low-violence versions that are typically less explicit and graphic in their depiction of violent acts. A more important limitation of the present study, however, is the reliance on a very brief self-report measure of physical aggression. The inclusion of only two items on physical aggression was due to the design of the survey that featured questions on large variety of topics. And while the additional inclusion of peer, teacher, or parent reports of aggressive behavior is desirable (Ferguson, 2011; Ferguson, Garza, et al., 2013; Ferguson et al., 2012; Gentile & Bushman, 2012; Krahé et al., 2012; von Salisch et al., 2011), this is not feasible for large-scale telephone surveys, especially if they also include adults. It is also possible that the effects we found are different for other types of aggression, such as verbal, relational, or indirect aggression (Möller & Krahé, 2009).

Another limitation of this study is that our use of age ratings as a proxy for violent content might be too crude. Even though violent content is one of the major criteria for the German USK age ratings (Hyman, 2005; MacMillan & Wedell, 2013), there are certainly others, such as sexual content or the complexity of the game mechanics (Busching et al., 2013). And while games with higher age ratings tend to feature more violent acts (Thompson et al., 2006), many games for younger audiences also contain some forms of violence (Thompson & Haninger, 2001). These types of violence usually differ from another on several dimensions, such as graphicness, realism, and justification (Tamborini, Weber, Bowman, Eden, & Skalski, 2013). The combination of a thorough content analysis and a longitudinal survey design by Shibuya, Sakamoto, Ihori, & Yukawa (2008) showed that the characteristics of video game violence, such as its justification, realism, graphicness, or punishment, seem to be more important than just the amount. However, most subjective ratings of violent content depend mostly or even exclusively on the graphicness of the portrayals (Gentile et al., 2011; Potter, 1999). Accordingly, self-reports of how violent a game is (Anderson et al., 2008; Gentile & Bushman, 2012) can be problematic, also because there are interindividual differences in what is perceived as violent. Expert ratings, on the other hand, can be expected to be less biased, but still bring about the difficulty of differences in expertise and, at the same time, strongly depend on the training of the coders and the stimulus material that is used, such as video recordings of a game or game reviews (Busching et al., 2013). To avoid the issue of interindividual differences in the evaluation of violent content, we opted for age ratings, but we acknowledge that there may be other measures of violent content that are more precise.

Games and genres that are violent, such as first-person shooters or fighting games, typically also differ from others on more dimensions than just violent content, including competitiveness or pace of action (Adachi & Willoughby, 2011; Elson, Breuer, van Looy, Kneer, & Quandt, 2013). Apart from game characteristics, it might be that there are other variables affecting the relationship between aggression and the use of violent video games that we did not control for in this study, such as academic achievement (Krahé et al., 2012; von Salisch et al., 2011; Willoughby et al., 2012), relationship with parents (Ferguson, Garza, et al., 2013; Wallenius & Punamäki,m2008; Willoughby et al., 2012), family violence (Ferguson et al., 2012; Ferguson, Garza, et al., 2013), or peer delinquency (Ferguson, Garza, et al., 2013; Ferguson et al., 2012; Willoughby et al., 2012). Finally, longitudinal studies remain correlational data, even though they can identify the temporal precedence between two or more variables. While we tried to control for potentially influential third variables, such as respondent sex, education, and overall use of video games, there may be other variables that influenced the temporal relationship of physical aggression and use of violent games, such as those mentioned earlier.

Despite these limitations, we believe that our study shows that individual differences between video game players need to be taken into account when studying the relationship between aggression and video game use. One important variable in this context is age, as it is closely related to both developmental change and the access to violent games. Because media preferences and personality traits tend to stabilize with age, both socialization and selection effects should be less likely for older players. Our replication of the findings by von Salisch et al. (2011) with data from an older and representative sample lends further support to the assumption of the Catalyst Model (Ferguson et al., 2008) that violent media do not have a substantial impact on aggressive personality or behavior, at least in the phases of late adolescence and early adulthood that we focused on. To more fully investigate the role of developmental change and age differences, future studies should include more and potentially also more fine-grained age groups; consider additional moderator variables, such as family violence or sensation-seeking; and look at longer periods than just 1 year. To explain the relationship between video game use and aggression, it is necessary to abandon monocausal and unidirectional models and to understand that video games are more than just stimuli that affect everybody in the same way. Media users are more active and media effects are more individual than most theoretical models would suggest.

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