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RESEARCH ARTICLE

Can Violent Video Game-Related Aggression Spread to Others? Effects on Retaliatory and Displaced Aggression

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Exposure to violent video games (VVE) has been shown to increase aggression in the player. In the present two experiments, we tested whether this effect spreads within a social network. In Experiment 1, using data from a previous study that showed an effect of VVE on aggression in a Competitive Reaction Time Task (Greitemeyer, 2014), we assigned the blasts of noise selected by players to new participants. Afterwards, they selected these parameters themselves. VVE had a causal effect on retaliatory aggression, showing that the effect of VVE may spread on non-players. In Experiment 2, 200 participants played either a violent or nonviolent video game and participated in a Cold Water Task (CWT) in which they assigned the time another person has to keep the hand in painfully cold water. Two-hundred new participants were yoked to one of the video game participants and had to keep their hand in the water for the indicated duration. Afterwards, they assigned the time to the video game participant (retaliation) or to another person (displaced aggression). Although VVE had no significant impact, we found that higher CWT duration led participants to behave more aggressively not only when retaliating, but also, to a lesser extent, in the displaced aggression condition. Implications of the spreading effect of aggression in the context of VVE are discussed.

Keywords: video games; aggression; contagion; social network

Introduction

Over the last decades, researchers have taken an interest in the relationship between media usage, personality, and behavior. This is especially true for violent media and its ties to aggression. According to Anderson and Bushman (2002: 28), aggression is '*any behavior directed toward another individual that is carried out with the proximate intent to cause harm.*' Specifically, abundant research has focused on the effects of violent video game exposure (VVE). Recent meta-analyses (Anderson et al., 2010; Greitemeyer & Mügge, 2014) showed that VVE leads to a small-to-medium increase in aggression.[1] In the present research, we provide the first experimental test of the idea that VVE does not only have an impact on the player, but also on individuals with whom the player is connected.

Previous research into the effects of VVE

Despite some studies finding no link between VVE and aggression (e.g., Kühn et al., 2018; McCarthy et al., 2016) and some even pointing to VVE decreasing aggression (e.g., Unsworth, Devilly & Ward, 2007), evidence suggests that frequently playing video games does make one more aggressive (for overviews, Anderson & Gentile, 2014; Krahé, 2014).

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VVE has been found to affect player cognition. For instance, Anderson and Dill (2000) found that playing violent video games led to an increased accessibility of aggressive thoughts. Likewise, hostile expectation bias (i.e., a tendency to perceive harmful actions perpetrated by others as more intentional than accidental) was more likely to appear in participants who had played a violent (in contrast to a nonviolent) video game (Bushman & Anderson, 2002).

Many studies have also shown a relationship between VVE and affect. For example, state hostility (Arriaga et al., 2006), short-term angry feelings (e.g., Carnagey & Anderson, 2005), and long-term trait anger (Bartholow, Sestir & Davis, 2005) rise with VVE. Conversely, several studies showed that VVE diminished empathy (Bartholow et al., 2005; Krahé & Möller, 2010).

Moreover, VVE has been associated with changes in behavior. Gentile, Lynch, Linder, and Walsh (2004) found that VVE was positively related to arguing with teachers and getting involved in physical fights. This correlational evidence was further supported by longitudinal studies showing long-term effects of VVE. For instance, Anderson, Gentile, and Buckley (2007) found that children who played more violent video games early in the school year were more verbally and physically aggressive several months later. Experimental designs corroborated the causal association of VVE and aggressive behavior. Playing a violent video game in comparison to a neutral one led

participants to behave more aggressively (Anderson & Carnagey, 2009; Gabbiadini & Riva, 2018).

Finally, there are also links between VVE and the player's personality. Recent research (Delhove & Greitemeyer, in press) found that a player's aggressive personality was positively associated with the selection of aggressive in-game roles. In addition, everyday sadists—those that derive pleasure from harming other people—have been shown to be attracted to violent video game play (Greitemeyer, 2015; Greitemeyer, Weiss & Heuberger, 2019). Other research (Greitemeyer & Sagioglou, 2017) showed that the relationship between VVE and everyday sadism is bidirectional, in that VVE also increases everyday sadism.

Given the popularity of violent video games and the relationship between VVE and aggression, there is growing concern about the societal impact of VVE. However, VVE may not only increase aggression in the players, but also in non-player individuals who are merely connected to a player. So far, most research on the impact of VVE has focused on the player's cognition, affect, behavior, and personality. The present study aims to address the causal effects of VVE on non-players tied to players.

Effects of VVE on the player's social network

Fischer (1982: 2) defined social networks as a '*set of people with whom an individual is directly involved*' (e.g., family, friends, romantic partner, acquaintances, coworkers). Direct involvement entails the existence of repeated interactions between a person and her/his network partner (see Wrzus, Hänel, Wagner, & Neyer, 2013).

Previous research has provided overwhelming evidence for the notion that psychological constructs can spread across network ties. A case in point is Christakis and Fowler's (2007) study on the spread of obesity within social networks. Using body-mass indices of a large sample over the course of more than 30 years, they found that one's likelihood of becoming obese increased by 57% if a friend had previously become obese. Overall, a wide range of psychological phenomena, such as smoking (Christakis & Fowler, 2008), well-being in the workplace (Chancellor et al., 2017), or cooperative behavior (Rand, Arbesman & Christakis, 2011) have been shown to spread in social networks (Christakis & Fowler, 2009, 2013).

There are at least three processes by which this spread can occur (Christakis & Fowler, 2013). The first one, known as homophily, stems from the fact that similar individuals are more likely to become friends with one another. For example, overweight individuals tend to prefer to befriend other overweight persons, whereas non-overweight individuals tend to prefer other non-overweight ones. The second process, called confounding, is a result of common environmental factors influencing both members of a network's dyad. For instance, a new fast food restaurant opening in the vicinity could influence two friends living in the same town by changing their eating habits, leading them both to gain weight. The last process is social influence, by which individuals induce their network partners to become similar. For example, an overweight person convinces a relative to abstain from pursuing sportive activities. In order to conclude that one's VVE indeed influences their friends' aggression, it is therefore important to show that this is due to the presence of social influence and not to homophily or a confound.

In line with this work, the General Aggression Model (GAM, Anderson & Bushman, 2002) assumes that aggression begets aggression. This prompts the question of whether VVE can affect not only the players but also their social networks. In a recent study, Greitemeyer (2018) displayed correlational evidence for this idea by showing that non-players whose social network consisted of violent video games players reported to be more aggressive. A longitudinal study (Greitemeyer, in press) found that VVE was associated with increased aggression in the player, which then instigated aggression in their social network over time. Similarly, Verheijen and colleagues (Verheijen et al., 2018) found that VVE predicts aggression of adolescents' best friend one year later. However, to the best of our knowledge, the spreading effect of VVE (i.e., increased aggression) has yet to be evaluated in an experimental setting. This is important insofar as only an experimental approach can unequivocally demonstrate that social influence processes are at work and any possible effects of playing violent video games are not due to spurious unmeasured variables (i.e., homophily and confounding).

Retaliatory and displaced aggression

The most frequently employed measure of aggression in laboratory settings is arguably the modified Taylor Competitive Reaction Time Test (CRTT, Taylor, 1967), where participants take part in a fake competition in a reaction time task and have to pick the duration and the loudness of blasts of sound as a punishment for the loser. Whereas the first trial measures unprovoked aggression, further trials are intertwined with blasts of noise directed at the participants, allowing to measure aggressive reaction to provocation. In those trials, aggression has been shown to converge on reciprocation of the levels of aggression ostensibly set by the opponent (e.g., Bushman & Baumeister, 1998; Twenge et al., 2001), illustrating how important reciprocation norms are in determining levels of aggression. Likewise, with VVE increasing the aggression in the player, it is expected that the target of this aggression will retaliate with their own aggressive response, potentially starting an aggression escalation cycle (Anderson, Buckley & Carnagey, 2008).

However, VVE may not only increase retaliatory aggression. Research has shown that individuals tend to react aggressively against a target that is innocent of any wrongdoing after the individual is provoked by another person (Marcus-Newhall et al., 2000). This tendency has been labelled displaced aggression. Hence, we further expected that VVE will not only increase retaliatory but also displaced aggression. This latter finding would provide strong evidence that the effect of VVE can spread through the player's social network because there is no direct link between the video game player and the displaced aggression victim.

The present research

The present two experiments are the first causal tests of the idea that the effect of VVE on aggression spreads from players to others. In Experiment 1, we employed previous data showing that violent (compared to nonviolent) video game play increases aggressive behavior in the first trial of the CRTT (Greitemeyer, 2014). New participants took part in the CRTT and were given the actual noise blast that had been assigned by one of the previous participants. We predicted that partners of a violent (compared to nonviolent) video game participant would exhibit more retaliatory aggression. Furthermore, this relationship was expected to be mediated by video game participants' level of aggression.

In Experiment 2, we examined whether partners of a violent video game player would not only exhibit more retaliatory but also more displaced aggression. In the first part, participants played a violent or nonviolent video game. Subsequently, we measured aggressive behavior employing the cold-water task (CWT). The CWT has been used on multiple occasions in the study of triggered displaced aggression (e.g., Pedersen, 2006; Pedersen et al., 2008; Pedersen at al., 2014; Vasquez et al., 2013). In the second part, new participants kept their hand in the cold water for the duration assigned by one of the video game players. Afterwards, aggression in the partners was assessed, employing the CWT again. We predicted that participants who played violent video games would be more aggressive and that this increased aggression would lead their partner to also behave aggressively towards others, be it their aggressor or an unrelated third party. However, given that displaced aggression is typically less pronounced than retaliatory aggression (e.g., Marcus-Newhall et al., 2000), the impact of VVE on retaliatory aggression should be more pronounced than the impact on displaced aggression. In the following sections, we report all measures, manipulations, and exclusions in these experiments.

Experiment 1

In a previous experiment (Greitemeyer, 2014), participants who played a violent (compared to a nonviolent) video game were more aggressive in that they chose higher intensity and duration levels of unpleasant noise blasts in the CRTT ($N = 99$). Note that violent video game play increased unprovoked aggression (i.e., the first trial) but did not affect provoked aggression (later trials of the CRTT). Given that a significant violent video game effect on the player's level of aggression is a prerequisite to establish that violent video game play may have a causal impact on aggression of a non-player who is connected to the player, participants in the current experiment only received the first noise punishment chosen by the previous participants. They were randomly yoked to one of these video game participants, suffered the noise punishment, and then had the opportunity to retaliate.

Method

Ninety-nine students (*partners*; 61 females, 38 males, M age = 22.7, SD = 3.0) of an Austrian university took part, one for each participant (*players*), in Greitemeyer's (2014) Study 2. Given that we yoked one partner to one player, we did not run an a priori power analysis to determine the necessary number of participants and instead ran the same number of participants as in the previous study. Partners learned that they would compete twice in a reaction time task against another participant who was allegedly in an adjacent room and that the winner could punish the opponent with bursts of white noise. At the beginning of each trial, partners were asked to set both the duration (ranging from 1 to 10) and intensity, from 60 decibels (Level 1) to 105 decibels (Level 10). A nonaggressive no-noise option (Level 0) was also offered. The computer was preprogrammed so that partners always lost the first trial. They then received the noise blast that was assigned by their assigned player. For each trial, noise intensity and duration levels were standardized and averaged. The first trial (unprovoked aggression) was used as a control when estimating the impact of VVE on retaliatory aggression, in order to control for interindividual differences. The second trial was used as the actual measure of retaliatory aggression.

Results

In line with our hypothesis, the player's level of aggression was significantly related to their partner's retaliatory aggression, $r(99) = .22$, $p = .026$. To test our hypothesis that increased aggression after violent video game play causally increases retaliatory aggression, we performed a multiple regression. Video game condition (coded −1 = nonviolent, 1 = violent) and unprovoked aggression were used as predictors for retaliatory aggression. The overall regression was significant, $F(2, 96) = 24.02$, $p < .001$, $R^2 = .33$. As expected, unprovoked aggression received a significant weight, $t = 6.80$, $\beta = .57$, $p < .001$, showing high stability in aggression levels. Most importantly, video game condition was also significantly associated with retaliatory aggression, $t = 2.31$, $\beta = .19$, $p = .023$.

We also examined whether the player's level of aggression would mediate the impact of the video game condition on the partner's retaliatory aggression. Please note that we controlled for partner's level of unprovoked aggression when we examined the relationship between video game condition and partner's retaliatory aggression. Given that this covariate could not have an impact on the relationship between video game condition and the player's aggression, to the best of our knowledge we could not run a bootstrapping mediation analysis. Hence, we followed Baron and Kenny's (1986) recommendation by employing the joint significance approach. In order to show a significant mediation effect, three conditions must be met: a) a relation between the independent and dependent variable; b) a relation between the independent variable and the mediator; c) a relation between the mediator and the dependent variable when controlling for the independent variable.

In the present experiment, the first condition was fulfilled: video game condition was associated with retaliatory aggression. The second condition was fulfilled in

Greitemeyer (2014) with video game condition being a predictor of player's aggression, $F(1, 97) = 5.40$, $p = .022$, $R^2 = .05$. To test the third condition, we performed a regression analysis testing the effect of video game condition, player's aggression, and unprovoked aggression on retaliatory aggression. The overall model was significant, $F(3, 95) = 18.31$, $p < .001$, $R^2 = .37$. Most importantly, player's aggression, $t = 2.22$, $\beta = .19$, $p = .029$, was a significant predictor of retaliatory aggression. Unprovoked aggression, $t = 6.84$, $\beta = .57$, $p < .001$, also received a significant regression weight, whereas game condition, $t = 1.77$, $\beta = .15$, $p = .079$, did not. Taken together, these results suggest that the player's aggression mediated the impact of video game condition on retaliatory aggression.

In accordance with recommendations from Yzerbyt, Muller, Batailler, and Judd (2018), we assessed the indirect effect using the Monte Carlo resampling method. This was conducted on R, using the Monte Carlo method for assessing mediation (Selig & Preacher, 2008). The confidence interval for the indirect effect (M = 0.092, 95% CI [0.001, 0.183] did not include 0, and was therefore considered to be statistically significant. The mediation model is presented in **Figure 1**.

Discussion

Experiment 1 provided initial evidence for our hypothesis that VVE has a causal impact on the player's partners. In line with our theoretical model, the video game participant's level of aggression mediated this effect. Given that the number of participants was relatively small, statistical power is an issue. Hence, we decided to run another experiment with an increased sample size. Some further limitations of Experiment 1 were also addressed.

Experiment 2

Experiment 2 conceptually extended Experiment 1 by testing whether the violent video game partners are not only more likely to retaliate, but also more likely to be aggressive against an innocent victim (i.e., displaced aggression). Moreover, Experiment 2 included all experimental conditions within one study. After participants played a violent or a nonviolent video game, their level of aggression was measured. Partners were then randomly yoked to one of these video game participants and suffered the assigned aggression level. Afterwards, we measured their level of aggression against the video game participant (retaliatory aggression) or against a different participant (displaced aggression).

Pretest

To obscure our hypotheses, video game participants in the main study were not asked to assess the violent content of the video game. Instead, we ran a pretest to ensure that the violent video games were indeed perceived as being more violent than the nonviolent ones. Twenty-one first year psychology students (66% females, *M* age = 20.4, *SD* = 1.43) evaluated the video games used in the main experiment for course credit. Participants were asked to play some video games. All games were free, flash-based games and were played on the website *Armor Games*. They were divided between violent (*Crush the Castle*, *Ricochet Kill 3*, and *Earn to die 2: Exodus*) and nonviolent games (*Demolition City*, *Sugar, Sugar 3*, and *Cyclomaniacs*).

Each participant had to play two video games for 20 minutes each. The games were grouped in three pairs with one violent and one nonviolent game each, which were presented in random order. After each game, participants evaluated them on a range of dimensions. Namely, games were evaluated on how difficult, fun, frustrating, exciting, fast-paced, violent, realistic, and competitive they were, as well as on how well one could identify with the game character and on the complexity of the controls (i.e., how difficult is it to act as you intend using the keyboard and mouse). Each of these dimensions was rated using a 7-point Likert-scale ranging from '*Not at all*' to '*Very*'.

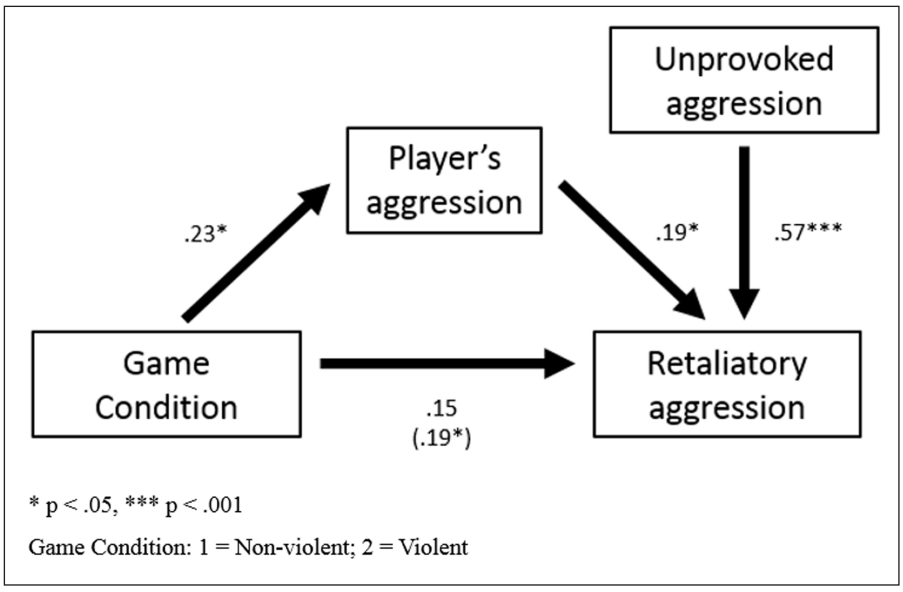

Figure 1: Mediation model of the impact of game condition on retaliatory aggression, mediated by video game player's aggresssion.

Using a paired sample t-test, we assessed the difference between violent and nonviolent games on all ten dimensions. In order to correct for multiple testing, α was divided by the number of comparisons (i.e., ten), meaning that the threshold for significance was considered to be $p < .005$. Violent video games ($M = 5.14$, $SD = 1.42$) were rated as having a more violent content than did nonviolent ones ($M = 1.57$, $SD = 0.93$), $t(20) = 9.68$, $p < .001$, $d = 2.97$. All other comparisons failed to reach significance, with all $ps > .005$ (for details on those, see *Supplementary Table 1*). Overall, the pretest showed that the violent video games were perceived as being more violent than the nonviolent video games.

Part 1

An a priori power analysis was conducted to determine the sample size. Given an expected effect size of r = .18 (Greitemeyer & Mügge, 2014), an α of .05, and a power of .80, a sample of 187 participants was required. In the end, we ran two-hundred adult volunteers (video game participants, 109 males, *M* age = 26.9, *SD* = 10.2) who participated in a 30-minute lab session in exchange for a monetary reward of 8€. Each experimental session was conducted with groups of one to six participants. Participants were told that we were interested in the link between certain personality traits and the capacity to learn new mechanics. This was supposedly measured by using a video game.

To ensure that our cover story was plausible, a number of personality traits were assessed. We included measures of the Big Five, trait aggression, and trait empathy. Given that these traits were not relevant for the present purpose, we will not discuss them in the following sections. All these results can be obtained from the first author upon request.

After filling in the three questionnaires, participants played a video game for 20 minutes. Before each session, one of the six games was randomly selected. After 20 minutes, the experimenter asked the participants to pause the game and to go back to the questionnaire. They were then asked to evaluate the game they just played on a few characteristics (i.e., difficulty, fun, frustration, excitement, pace, identification with the character), and to write down the thoughts they had during the game. Participants also had to indicate how often they play video games usually, by answering the question '*How often do you play video games?*' using a scale ranging from 1 (*never*) to 7 (*very often*). Finally, participants were asked to indicate their current mood on a scale from 1 (*bad*) to 7 (*good*).

When the experimenter indicated that the experiment was over, they asked the participant to help with one final task. Participants learned that we were pretesting a new task for a future study aimed at assessing the effect of physical distraction on people's memory. In fact, participants took part in the CWT. They were asked to keep their hand for ten seconds in cold water (10°C), in order to have a clear perception of the stimulus. The experimenter ensured that each participant moved his/her hand in the water in order to prevent warmer water to build up around the hand. Participants were then asked to choose the time (on a scale from 0 to 90 seconds with 5 seconds intervals) that another participant had to keep the hand in the water. Researchers explained that the duration they would choose would randomly be applied to a single individual, and that picking the 0 second duration would mean that the person paired with them would be part of a control group. Finally, participants were asked to write down what they believed to be the goal of the study (13 participants noted that we were interested in the relation between video game and aggression). They were then thanked and paid for their participation.

Part 2

In following lab sessions, another 200 adult volunteers (partner participants, 110 males, mean age = 22.54, *SD* = 5.49) participated in a 10-minute experiment, in exchange for a monetary reward of 3€ or for course credit (36.5%). Each experimental session was conducted with groups of one to four participants. Due to encoding errors, two participants' CWT responses were not recorded, and they were therefore excluded from the sample for a total of 198 participants remaining.

Partner participants were randomly assigned to one of two experimental conditions: retaliation vs. displaced aggression. In the retaliation condition, partner participants were divided equally between two rooms and were asked to assign the time the video game participant who chose their own task's duration had to keep the hand in the cold water. In the displaced aggression condition, partner participants stayed in the same lab and assigned the time an unknown participant had to keep the hand in the water. All partner participants then learned that we were interested in the effect of physical distraction on short-term memory.

Partner participants were then asked to complete a short questionnaire. This questionnaire was the same as the one from Part 1, containing demographic questions, as well as the same personality traits. Upon completion, partners proceeded to the CWT, which was presented as a physical distraction task. As for Part 1, cold water (10°C) was used. However, partner participants were asked to keep their hand in the water for varying duration. Each partner participant was randomly yoked to one video game participant from Part 1 and asked to complete the task with the duration indicated by the video game participant. Partner participants in the retaliation condition were told that one of the participants in the second lab was paired with them. This other person was supposedly chosen to go first in deciding the duration of the task, and partner participants had to set the duration in their turn for this person. Partner participants in the displaced aggression condition were told that the duration was assigned to them by a previous participant and asked to indicate the duration they wanted to give to the next ones. It was stressed that this person was not the participant that assigned them the time. The same interval was used as in Part 1 (between 0 and 90 seconds with 5 seconds intervals).

Finally, partner participants took part in a short bogus memory task before being asked two last questions. As a manipulation check, they were asked to indicate whether

the person that would have to do the CWT for the duration they picked was the same as the one who chose the duration of their task. However, participants indicated that the wording of this item was confusing, so this item is not considered further. Finally, they were asked to write down what they believed was the goal of the study (17 participants pointed that we were interested in the spread of aggressive behavior). They were then thanked and paid for their participation.

Results

Part 1. In order to evaluate the effect of the manipulation on participants' behavioral aggression, we compared the CWT score of all three violent games ($M = 31.24$, $SD = 23.04$) to the non-violent games ($M = 26.21$, $SD = 20.42$). Contrary to expectations, violent video games did not increase aggression in comparison to non-violent ones, $t(198) = 1.63$, $p = .104$, $d = 0.23$. Excluding participants who showed awareness to the aim of the study did not affect this pattern, $t(185) = 1.48$, $p = .14$, $d = 0.22$.

Correlation analyses showed CWT duration correlated negatively with game perceived frustration ($r(198) = -.26$, $p < .001$). General game use correlated negatively with sex ($r(198) = -.40$, $p < .001$), age ($r(198) = -23$, $p = .001$), and game perceived difficulty ($r(198) = -.15$, $p = .031$). It also correlated positively with present feeling ($r(198) = .26$, $p < .001$) and game perceived fun ($r(198) = .20$, $p = .005$). The complete correlation table is available in *Supplementary Table 2*.

Part 2. Given the absence of a VVE effect on aggression in Part 1, it makes little sense to examine whether violent video game condition has an impact on partner's aggression. Instead, we examined the possible spreading effect of aggressive behavior. We predicted that duration (i.e., how long partner participants had to keep their hand in the water) was associated with partner participants' CWT responses (i.e., the duration they selected). Moreover, this relationship should be more pronounced for retaliatory aggression than for displaced aggression.

In fact, CWT response correlated positively with duration ($r(198) = .44$, $p < .001$), showing that participants who received higher duration gave higher responses. We then examined the possible moderating effect of retaliatory vs. displaced aggression. The model (**Figure 2**) was significant, $F(3, 194) = 19.05$, $p < .001$, $R^2 = .23$. Effect of CWT duration on CWT response was significant in both conditions, but was stronger in the retaliatory (b = .54, $SE = .08$, $t = 7.01$, $p < .001$) than in the displaced aggression (b = .22, $SE = .08$, $t = 2.82$, $p = .005$) condition. Again, exclusion of participants who showed awareness to the aim of the study did not influence the results, $F(3, 177) = 17.00$, $p < .001$, $R^2 = .22$.

Discussion

Our second experiment failed to show an effect of VVE on aggressive behavior. However, when taking into account the relatively small effect size found in previous meta-analyses (Anderson et al., 2010; Greitemeyer & Mügge, 2014), it is not surprising that some studies will fail to show such an effect. Despite having run a power analysis and being over the recommended power of .80, there is still a 20 percent chance of a type II error. This lack of effect may also stem from the flash games employed here that are minimalist in terms of gameplay and realism, although previous studies showed VVE effects with similarly simplistic games (e.g., Anderson & Ford, 1986). Furthermore, Barlett, Rodeheffer, Baldassaro, Hinkin, and Harris (2008) have failed to show a moderation effect of graphic realism on the link between VVE and aggression. Behavioral realism also did not show any moderating effect (Zendle, Kudenko & Carins, 2018).

Despite the absence of any VVE effect on the video game player's level of aggression, it is notable that aggression levels did spread. Longer duration of the CWT set by the first group of participants elicited change in the responses of their partners. In accord with our expectations, when they were aggressed (i.e., assigned longer duration), partners chose higher duration of the CWT not only when retaliating, but also (although to a lesser extent) to unrelated third parties. Therefore, we replicated results from the displaced aggression literature (Marcus-Newhall

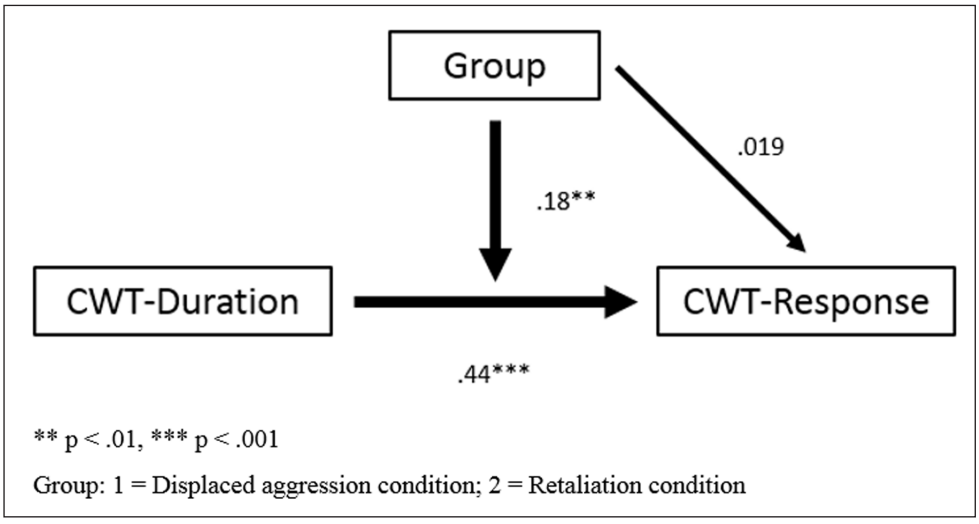

Figure 2: Regression coefficients for the relationship between CWT duration and response, moderated by target group.

et al., 2000), showing that aggressive behavior, such as those expected from VVE, leads not only to retaliation but also to increased aggression against innocent others. This means that VVE may not only affect the players and their entourage but also third parties that do not even know the video game player. Of course, given that VVE had no significant impact on the video game player's levels of aggression in our experiment, this conclusion is rather speculative and is in need of further research.

General Discussion

The present work experimentally assessed whether the effect of VVE spreads from players to others. Based on previous theoretical and empirical work on VVE, social networks, and aggression, we hypothesized that participants who played a violent video game, as opposed to a non-violent one, would show increased aggressive behavior and that this would lead the aggressive victims to become more aggressive themselves. Furthermore, it was expected that this would be the case when the targets of the aggression were retaliating towards their aggressor, but also when they were interacting with unrelated third parties (displaced aggression).

Overall, our research provided tentative support for our hypotheses, showing that VVE raised aggression not only in players but also in people interacting with them, who responded aggressively to aggression (Experiment 1). Furthermore, aggression following video game play can cause not only retaliation but also displaced aggression (Experiment 2). Taken together, these studies suggest that VVE has the potential to be responsible for higher aggression not only in the player but also in people with whom they interact. This supports previous correlational (Greitemeyer, 2018) and longitudinal (Greitemeyer, in press; Verheijen et al., 2018) work in claiming that VVE can influence not only players but also their social network. With a majority of the recent most popular video games being violent, this concern seems relevant to our society. However, it should be pointed out that aggression is undoubtedly influenced by a large variety of parameters and that the effect size of VVE is only small to medium. In fact, Experiment 2 did not show that VVE leads to increased aggression.

Of course, our work is not without limitations. As just noted, there was an absence of VVE's effect on aggression in Experiment 2. Nevertheless, Experiment 1 did support our hypothesis that people retaliate aggressively to VVE-related aggression. Future research should replicate the spread of VVE-related aggression in a displaced aggression context.

Another explanation could stem from the use of the CWT. Despite this task having been used many times before, participants' reaction to the task varied from mild unpleasantness to actual cold-induced pain. It is thus possible that the parameters of the task were not optimal and that the CWT failed to capture aggressive behavior, causing our null effect. In the field of pain studies, a similar paradigm called the Cold Pressor Test has been used (Mitchell, MacDonald & Brodie, 2004). Although the temperature used in such studies are generally lower (between 0°C and 7°C), Mitchell and colleagues (2004) found that changes of only two degrees had an impact on pain responses. In the future, we may want to consider using different parameters, such as colder water, in order to ensure that the task works as intended.

We would like to mention the use of unrelated participants. Our definition of social network entails direct involvement of the parties. In the present studies, the partners did not know each other and never met. It is possible that the interaction between individuals who actually know each other and have a shared history would differ from our sample. That being said, recent works (Greitemeyer, 2018, in press; Verheijen et al., 2018) using actual social networks have found that VVE effects can spread. Therefore, our findings should be considered in light of these, as a support for this claim. In the future, using similar experimental approaches set in an actual network would allow us to better assess the spread of VVE effects.

Future efforts should also consider the possibility that the observed spread goes beyond the direct relation between two individuals. If violent video game players' friends are acting more aggressively towards third parties, it is possible that these new persons also move towards more aggressive behaviors themselves. Indeed, research on social networks has found psychological constructs to spread to three degrees of separation (Christakis & Fowler, 2009, 2013). That is, individuals can influence their friends who in turn influence their own friends who finally have an impact on their friends.

In the present research, we addressed the possibility that violent video game play had a causal impact on the level of aggression of participants that did not play a video game themselves but were connected to a player. It is important to note that positive effects of video game play on the player's social network are also possible. For example, it has been shown that prosocial (Greitemeyer & Osswald, 2010) and cooperative video games (Greitemeyer, 2013) have a positive impact on the player's prosocial feelings and behavior. Given that prosocial behavior has been also shown to spread in human social networks (e.g., Fowler & Christakis, 2010), it is plausible that prosocial video games do not only have a positive impact on the player's social behavior, but also on others who are connected to the player.

Conversely, as aggression is multidetermined, with violent video game play being only one source among many others, it is highly likely that other sources of aggression also have indirect effects. In fact, recent research (Greitemeyer & Sagioglou, in press) showed that individuals who perceived themselves to be unfairly disadvantaged respond with increased aggression, which then was associated with increased aggression in the individuals' friends (even when controlling for the extent to which these friends perceive themselves to be at a disadvantage). It is thus important to not only consider the direct effects of an antecedent of aggression, but also the possibility that aggression is increased in others that are not exposed to this antecedent but are connected to someone who is.

Conclusion

Existing correlational (Greitemeyer, 2018) and longitudinal (Greitemeyer, in press; Verheijen et al., 2018) studies support the claim that VVE-related aggression spreads within social networks, but, to the best of our knowledge, no such experimental study has tested this idea so far. We indeed showed that increased aggression due to VVE causes people to retaliate aggressively (Experiment 1). Existing literature on displaced aggression and data from the present work also suggest that this spread has the potential to influence unrelated third parties as well, albeit to a lesser extent (Experiment 2), but this still needs to be tested in an experiment that successfully replicates the effect of VVE on the player's aggression. Whereas VVE has already been shown to be a relevant societal concern, it appears that its effect on aggression cannot be limited to players but also extend to their social network. However, given that our second experiment failed to find a significant effect of VVE on the player's level of aggression, more research is necessary before a firm conclusion is warranted that VVE affect people who do not play violent video games but are connected to someone who does.

Note

[1] Hilgard, Engelhardt, and Rouder (2017) have stated that this effect may be overestimated due to publication bias (but see the response from Kepes, Bushman & Anderson, 2017).

Additional Files

The additional files for this article can be found as follows:

- **Supplementary Table 1.** Paired-sample T-test of the difference between non-violent and violent games on their characteristics. DOI: https://doi.org/10.5334/irsp.242.s1
- **Supplementary Table 2.** Bivariate correlations between CWT duration, general game use, and game perception in Experiment 2, Part 1. DOI: https://doi.org/10.5334/irsp.242.s2
- **Supplementary Table 3.** Bivariate correlations between CWT duration, general game use, and personality in Experiment 2, Part 1. DOI: https://doi.org/10.5334/irsp.242.s3
- **Supplementary Table 4.** Bivariate correlations between CWT response, duration, and personality in Experiment 2, Part 2. DOI: https://doi.org/10.5334/irsp.242.s4

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Competing Interests

The authors have no competing interests to declare.

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