Computer and video games have almost become an integral part of young people’s leisure time. This statement is supported not only by the sales figures in the software industry – $7.4 billion worth of entertainment software was sold in the U.S. in 2006 (Entertainment Software Association, n.d.) – but also by the results of representative surveys on media use (Feierabend & Rathgeb, 2006; Kaiser Family Foundation, 2002, 2005). Moreover, video games with violent content are extremely popular (Vorderer, Bryant, Pieper, & Weber, 2006).

As children and teenagers in particular dedicate a significant part of their leisure time to such games, they are frequently exposed to violence and aggression. This exposure raises specific concerns: What effect does the violent content of video games have on consumers (particularly children and adolescents)? Do the potential effects influence the development of aggressiveness and aggressive behavior? The search for answers within the scientific discourse has considered topics such as identification with game characters, learning aggressive behavior, and the attribution of arousal and habitual processes. The aim of the present study is not to confirm any increase in aggression or decrease in empathy and prosocial behavior due to violent video games. Instead, it is to test an alternative explanation, namely, the desensitization hypothesis, according to which prolonged presentation of aggressive content leads to a decrease in the sensitivity to such stimuli (“hardening”). The study will also examine whether violence in video games leads to an increase in arousal.

Video games are attracting increasing public attention and becoming a cause for concern in society because of their explicit presentation of violence. Early examples of these games were the fight game Mortal Combat™ or the game DOOM™ released in 1993. The latter was a revolutionary...
development on the game market with its spectacular 3D graphics and dark and vivid atmosphere. It has been regarded the archetype of all “first-person shooters.” Since then, these first-person shooters have become more and more popular. It can be assumed that the first-person perspective and the way events occur in real time lead to a greater identification with the main character of the game. Aggression and violence are experienced more directly than in other games, and the most important strategy is to exhibit a quick stimulus-reaction pattern in order to kill suddenly appearing opponents. Hence, acting highly aggressively is rewarded permanently as the only efficient strategy for winning the game. Furthermore, detailed settings and a realistic order of events are particularly important marketing features when developing first-person shooters. This closeness to reality increases the concern that players will find it easier to associate the content with reality. The issue is then whether and how cognitive structures and actions from a video game actually are transferred to reality. According to Fritz’s (1997) model, games can be used to acquire and test response alternatives, and this can probably be transferred to real life.

Rapid technical advances in the hardware sector have made it possible for software developers to increasingly refine their products. As a result, the object of research is changing constantly. In a meta-analysis, Sherry (2001) showed increasing effect sizes over time. This would seem to limit the explanatory value of older studies (up until the early 1990s) for today’s players. The empirical basis is further limited by the rather low validity of the small number of studies available.

In their review, Dill and Dill (1998) concluded that playing violent video games can cause an increase in aggressive behavior or variables associated with aggression (arousal, affect), combined with a decrease in prosocial tendencies (for other reviews, see Gentile, 2005; Gentile & Anderson, 2003). When studies failed to show the expected connections, the authors generally attributed this to methodological problems. Griffiths’ (1997) conclusion, which was based on a study of the relevant literature, was that one can indeed propose that violent video games promote aggression. However, he considered that the available studies were too few and the methods employed too diverse to make a clear statement. Bensley and van Eenwyck (2001) reached a similar conclusion. Although they were able to establish that violent behavior in young children increased after the children played video games, results were ambiguous for teenagers and university students.

In sum, present research can indicate only a vague connection between video games and an increase in aggressive behavior. Researchers still know less about the effects of video games than about the effects of television (Paik & Comstock, 1994).

The theoretical basis of this study is Anderson and Bushman’s (2002) General Aggression Model (GAM) that combines different theories of human aggression. The model describes how aggression and aggressive behavior arise in social situations. Personal characteristics (e.g., genetic and developmental factors), personal knowledge structures, and characteristics of the situation shape an individual’s current internal state. This state, made up of a cognitive, an affective, and an arousal component, determines the behavior – whether it be a spontaneous reaction or a well-thought-out action. One possible mechanism through which media violence might have an effect is by priming certain schemata or scripts associated with aggression. This would make them more salient, giving them both a greater importance and an advantage in information processing. At the same time, schemata that inhibit aggression such as empathic or prosocial structures may be less activated. In their meta-analytic review, Anderson and Bushman (2001) documented the effects of violence in video games on the three components of the internal state. Summarizing data from 35 studies and 4262 participants, they showed an influence on aggressive cognitions ($r = .27$) and affects ($r = .18$). They also found an increase in physiological arousal ($r = .22$). But, above all, it seems that violence in video games influences behavior. Aggressive behavior is strengthened ($r = .19$), and prosocial behavior is weakened ($r = -.16$). The model is also supported by experimental results (Anderson & Dill, 2000; Bushman & Anderson, 2002). In his meta-analysis, Sherry (2001) calculated different effect sizes depending on study design ($r = .11$ for experimental studies, $r = .16$ for surveys). He also reported that effect sizes differed as a function of other methodological features such as the type of outcome measure ($r = .09$ for behavioral and $r = .19$ for paper-and-pencil measures), and the amount of time participants played the violent game (decreasing effects with longer exposure). However, in the case of violent video games, it is not just the short-term consequences that are important for a player’s behavior. Prolonged and continuous consumption can be expected to have even more severe long-term consequences. Anderson et al. (2004) suggested an extension of the GAM to explain such long-term consequences of violent video games. In this model, prolonged and repeated consumption of such video games supports the development of an aggressive personality by increasing aggressive expectations, perception, attitudes, and conduct.

Measurements of arousal as a physiological activation manifesting in different physiological parameters (e.g., heart rate, respiration, skin conductance, electromyography) play a special role in estimating the effects of video games on people’s mental processes and behavior. According to Huesmann, Moise, and Podolski (1997), aggressive behavior is more probable when excitation is increased. Anderson and Bushman (2002) also drew attention to the role of excitement when handling social situations, and take this into account in their aggression model (GAM).

Different studies have examined whether the level of arousal caused by a video game depends on the level of violence. Anderson and Bushman’s (2001) above-mentioned meta-analysis found a mean effect size of $r = .22$ for this. Calvert and Tan (1994) compared people who had played an aggressive virtual reality game with people who had
watched them playing and a control group. The group of players revealed an increase in aggressive cognitions as well as a significant increase in heart rate as compared to the other two groups. The authors concluded that this supported the arousal hypothesis.

Ballard and Wiest (1996) found a significant increase in heart rate and systolic blood pressure as well as higher scores in an aggression inventory in people who had played a very aggressive video game for 10 min as compared to those who had played less violent games. They concluded that a higher level of violence results in stronger physiological arousal, thus causing more hostility and aggression in the players and that this, in turn, may well also have an impact on their behavior. In a within-subjects design, Frindte and Obwexer (2003) reported a significantly higher level of arousal when people played a violent video game compared to a nonviolent game.

Due to the small number of studies, there is still no satisfactory answer to the question concerning the physiological short-term effects of video games. No simple homogeneous influences have been found, particularly not with respect to different parameters of cardiovascular activity (systolic and diastolic blood pressure, heart rate). Most recent studies have used single measurements instead of continuous ones. Nonetheless, a tendency toward an increase in arousal during video games can be found. In the present study, the arousal hypothesis predicts that playing video games will generally have a stimulating effect, that a player will show an increase in physiological arousal, and that this will be even stronger in participants playing games with a higher level of violence.

In line with the GAM, aggressive affect should increase in participants after they have played violent video games. The affective response includes reactions to aggression-related emotional stimuli. Because this kind of cue configuration is crucial for good performance in the game, it guides a player’s behavior. It is particularly important for attaining goals (active aggressive behavior, killing opponents) and avoiding failure (perceiving and handling threats, avoiding getting killed). It is most functional to give more weight to such stimuli in perception and information processing. The assumed affective process can be regarded as being linked to priming mechanisms on a cognitive level. Therefore, the sensitization hypothesis predicts that priming processes will pre-activate aggressive cognitive schemata and increase their availability.

The desensitization hypothesis predicts that prolonged confrontation with descriptions of violence on the screen will habituate the recipient to violence. Thus, reactions to violence in the media as well as in other areas of life weaken. This affects the perception of violent acts themselves as well as their consequences (e.g., injuries, harm, suffering). Likely implications are a lower level of physiological arousal and weaker affective reactions to real-life violence, a reduction in the perceived severity of violent acts and their consequences, as well as a reduction in empathy for victims of violence. Desensitization is a component of the long-term GAM mentioned above. Huesmann et al. (1997) anticipated that violent media induce such desensitization. Violence and aggression are increasingly seen as being normal, and their use as a means of punishment, goal attainment, or for personal benefit is tolerated. The result is an increased likelihood of aggressive behavior.

Desensitization may well have an impact on how people judge situations and alternative behavior in social situations (Kirsh, 1998). Cognitions may become biased toward aggressiveness. In an experiment on the desensitizing effect of movies with sexualized violence, Mullin and Linz (1995) showed participants “slasher movies” on three successive days. At the beginning, participants were influenced negatively: They showed increased affective responses like higher scores on hostility, anxiety, and depression. However, the effect of the movies weakened over the course of the experiment, and the participants recognized less violence. These results alone are proof of desensitization. But the habituation also transferred to other areas: Compared with a control group, desensitized participants showed less sympathy for victims of violence and judged their injuries to be less serious.

Similar desensitization effects can also be found for violence in video games. In one experiment, male college students played either a more violent or a less violent video game (Deselms & Altman, 2003). Those who had played the more brutal game rated lower sanctions to be appropriate for crimes of violence than those who had played the more peaceful game. This would suggest that they judged violence to be less serious after experiencing the violent video game.

Desensitization or hardening might also impair natural mechanisms to counter aggressive behavior (Dill & Dill, 1998). This would result in an increased likelihood of violent behavior and a reduced likelihood of prosocial behavior (e.g., helping victims of violence, see Füllgrabe, 2002). In her study on the desensitization effects of video games, Steckel (1998) examined the reactions of children after they had played either a violence-oriented or a violence-free game for 20 min. Those who had played the violent game showed weaker emotional reactions to pictures designed to induce emotions and, above all, weaker empathic reactions. They also looked at the pictures longer than the other children did. The results were interpreted as indicating that violent video games lead to a reduction in emotional reaction and sympathy. A connection between violent video games and both lower empathy and a stronger aggressive attitude was also established in a survey taken at secondary schools (Funk, Baldacci, Pasold, & Baumgardner, 2004).

The main issue in the present study is whether and how video games have an effect on perception and emotional experience. It particularly examines whether consuming violent video games causes short-term habituation to aggressive and aversive stimuli. According to Anderson and Dill (2000), such a process could form the basis of long-term desensitization. How are aggressive and aversive stimuli processed when a violent video game has been played? Be-
cause of the limited empirical evidence, it is not clear a priori which processes are significantly involved here. There are two possible models: First, in accordance with the sensitization hypothesis, aggressive stimuli may trigger priming processes that pre-activate aggressive cognitive schemata, making them more available to the individual. A player may react particularly sensitively to aggressive content, because, in popular video games, aggressive actions and stimuli are essential for success. Second, in accordance with the habituation hypothesis, it can be expected that a violent video game constantly confronts the player with aversive as well as aggressive content and that he or she becomes used to such stimuli. In contrast, a person who has not played the game will be affected much more by these stimuli.

**Method**

**Sample**

Participants were 42 males; 33 had a general university entrance qualification, 3 had advanced technical college entrance qualifications, and the remaining 6 had at least a secondary school leaving certificate. Due to technical problems, some of the data from two participants could not be used. Therefore, when group comparisons are based on different sample sizes, these are listed separately. Participants were aged 18–30 years (M = 22.33, SD = 2.92) and were recruited through public notices in video rental stores and schools as well as announcements given during university lectures.

**Materials and Instruments**

**Computer games**

Several authors have pointed to a methodological problem when comparing the different video games used in experimental settings (Klimmt & Trepte, 2003; Ladas, 2002). In many previously published studies, games differed not only in their level of violence but also in other aspects such as speed, degree of difficulty, plot structure, or the degree of player involvement. When games differ on more than one variable, possible between-group differences in results cannot be attributed reliably to the effect of violence. To take this into account, it would be best to avoid using nonviolent games in the control condition. Hartig, Frey, and Ketzel (2003) have also pointed to this problem and suggested suitable modifications (mods) and additional modules as a solution.

The present study manipulated the level of violence in a single video game (high vs. low level of violence) as the independent variable. Different modifications of the first-person action shooter *Unreal Tournament 2003* were used for this purpose. First-person shooters are particularly suitable for research on the effects of violence because of their characteristics (see above). Furthermore, they are very popular, widespread, and, in addition, easy to operate. A mod is a version of an existing game programmed by users. It uses the same basic program, but can differ significantly from the original. The mods for this research were taken from the Internet and video game magazines (Gamestar, 2003).

In the game, two teams of figures fight against each other in an arena with different weapons. The player belongs to a team with three virtual teammates fighting against four virtual enemies. Differences between the two versions are shown in Table 1. Because “frozen” teammates can be “defrosted” and thereby brought back into play by standing next to them, the “gameplay” differs considerably in the two conditions. Although both versions include aggressive acts like shooting and attacking, the consequences are quite different. In the high-violence condition, aggressiveness is increased by manipulating not only the graphicness of violence (bloodiness, realism), but also its impact on gameplay (motivations, consequences).

**Arousal measures**

The general level of arousal during the experiment was recorded by measuring heart rate and respiration continuously with a Biopac Student Lab PRO (Biopac Systems, Inc.). A standard limb lead configuration (bipolar) was used to make electrocardiographic (ECG) recordings. Respiration data was collected using a sensor with a piezo element measuring respiration effort.

**Emotional stimuli**

To test habituation to violent and aversive stimuli, 60 photographs were chosen from the International Affective Pic-

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**Table 1**

<table>
<thead>
<tr>
<th>Main Differences in Game Features in the Two Experimental Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental condition</strong></td>
</tr>
<tr>
<td><strong>Goal</strong></td>
</tr>
<tr>
<td>Kill as many enemies as possible!</td>
</tr>
<tr>
<td><strong>Weapons</strong></td>
</tr>
<tr>
<td><strong>Graphical effects of hits</strong></td>
</tr>
<tr>
<td><strong>Sound effects of hits</strong></td>
</tr>
</tbody>
</table>

Swiss J Psychol 67 (1), © 2008 by Verlag Hans Huber, Hogrefe AG, Bern
tured System (IAPS) (Lang et al., 1999). These included pictures of seriously injured people, threatening situations, but also pictures of landscapes and animals. The pictures were chosen with the aim of inducing different emotions. Ten pictures had an aggressive background; ten were aversive (see appendix for IAPS codes). To avoid a habituation effect through the sole use of materials stimulating one single emotion, aggressive, aversive, and neutral pictures were presented on a PC in random order. Sensitivity to the pictures was assessed on two different levels:

1. Emotional reaction: Participants rated the pictures on 5-point scales for valence, ranging from 1 (very pleasant) to 5 (very unpleasant), and arousal, ranging from 1 (low arousal) to 5 (high arousal). They used the Self-Assessment Manikin (SAM) as a visual anchor (Lang, 1980, as cited in Lang et al., 1999, p. 1). The SAM figures had corresponding numbers as a background.

2. Physiological reaction: Physiological reactions to the pictures, particularly the aggressive and aversive ones, were measured by recording differences in skin conductance as an indicator of galvanic skin response (GSR). Electrodes were placed on the middle fingers of the non-dominant hand. To reduce artifacts due to random hand movements, participants were instructed to rest the hand gently on the table.

Player’s characteristics

Trait aggression was assessed using the following three scales from Hampel and Selg’s (1975) Fragebogen zur Erfassung von Aggressivitätsfaktoren (FAF), an aggressivity factors questionnaire: (a) spontaneous aggression: 19 items measured uncontrolled verbal, physical, and fantasized aggression against humans and animals (Cronbach’s ρ = .79). (b) reactive aggression: 13 items measured aggressive self-enhancement while having an adjusted attitude (Cronbach’s ρ = .68). (c) excitability: 13 items measured irritability, affect regulation, and frustration tolerance (Cronbach’s ρ = .78).

Gaming experience was recorded with two 6-point items (number of playing hours per week, gaming experience in years; Döbler, Stark, & Schenck, 1999; Ladas, 2002). Following Colwell and Payne (2000), the product of these two ratings was used to estimate the overall gaming experience. To create extreme groups, this index was used to divide the sample into three equal-sized groups. Analyses were then based on the upper and lower tertiles.

Procedure

Participants were tested individually using a desktop computer in a laboratory. They were assigned randomly to one of the two experimental conditions. Each session started by fitting electrodes to record GSR, respiration, and ECG throughout the experiment. After the participant had completed individual questionnaires, an HTML data file introducing the game was started on the computer. This file differed for each experimental condition. The participant read the instructions and then played either the high- or low-violence version of the video game for 20 min. Participants wore headphones while playing. Then the pictures were shown for 6-s each. Judgments on each picture were made via the computer keyboard. Then the electrodes were removed, and participants filled out a questionnaire on demographic data and previous experience with video games and movies. They were debriefed afterwards.

Data Analysis

Baseline heart rate was obtained by measuring participants’ average heart rate while they filled out questionnaires and read instructions. Participants’ heart rate was measured continuously while they played the video game; the average heart rate during game play was calculated. Participants’ reaction to the video game was assessed by the difference score obtained by subtracting the baseline heart rate from the average heart rate while playing. The respiration score was calculated analogously.

The continuous measurement of skin conductance (in μΩ) resulted in a conductance curve smoothed by a moving average (over 150 data points). Data from a 7-s interval, which began with the presentation of each picture, were used for analyses. By calculating the area under the curve for this interval, an index of skin conductance was computed for each picture (μΩ/s). To control for respiration effects, a reaction to a picture was ignored if a deep breath was noticed shortly before or within the 7-s interval because this can cause an increase in conductance. To avoid any influence of individual differences in general skin conductance and sensitivity, the data for all 60 picture viewings were standardized with a z-transformation.

Extreme values for each picture were eliminated (separately for the experimental groups). To check whether the selected pictures provoked the intended affect, a discriminant analysis of the ratings of arousal and valence as well as the electrophysiological response was used to create groups of pictures that were as distinct as possible. The intended pictures were arranged in the two relevant stimuli categories. For further analysis, in order to achieve a high difference between and homogeneity within categories, the eight pictures that fit best into the categories were used.

Results

Arousal

Heart rate

Unexpectedly, the average heart rate during the video game \( (M = 78.83, SD = 10.20) \) was lower than the baseline heart rate.
rate \((M = 80.57, SD = 10.69), t(40) = 2.339, p = .024, d = -.17\). An inspection of heart rates measured during the baseline period and during the video game (Table 2) revealed a difference between the two groups. The mean difference in the high-violence group was significantly higher than that in the low-violence group, indicating that arousal in the high-violence group was continuously increased.

**Respiration rate**

The respiration rate also decreased significantly over the course of the experiment. The baseline respiration rate \((M = 18.79; SD = 1.27)\) was higher than that measured during the game \((M = 17.94; SD = 2.46), t(40) = 2.84, p = .007, d = -.38\). However, closer examination revealed that this was caused by a higher decrease in respiration during the high-violence game. The difference between the baseline and game-time respiration rate tended to be higher in the group playing the violent game. The decrease in respiration rate was higher in the high-violence than in the low-violence group. This seemed to contradict the prediction derived from the arousal hypothesis.

Since continuous data were recorded, we were able to track the development of physiological activation in the two groups over the course of the experiment. The descriptive data displayed in Figure 1 indicate a general decrease in heart rate. Although there was an interval of increased activity at the beginning of the game in the high-violence group, there was no such increase in the low-violence group.

**(De-)sensitization**

**Subjective judgment**

The stimulus material (IAPS pictures) was generally judged to be very unpleasant and moderately exciting. For both aggressive and aversive stimuli, the two experimental groups did not differ in their judgment of the pictures on either the arousal or the valence dimension (Table 3).

**Physiological reaction to aversive stimuli**

The mean of the averaged standardized reaction to the eight aversive pictures was significantly lower in the high-violence group than in the low-violence group (Table 3). This was in contrast to the effect of aggressive pictures. In this case, the data, which can also be seen in Figure 2, supported the hypothesis that violence in a video game causes desensitization to aversive stimuli.

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**Table 2**

*Mean Changes in Heart Rate and Respiration Rate (Game Period – Baseline Period) in the Experimental Conditions*

<table>
<thead>
<tr>
<th></th>
<th>High violence(a)</th>
<th>Low violence(b)</th>
<th>(t)</th>
<th>(p)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in heart rate</td>
<td>(-.25)</td>
<td>(3.66)</td>
<td>(-3.17)</td>
<td>(5.33)</td>
<td>(2.04)</td>
</tr>
<tr>
<td>Change in respiration rate</td>
<td>(-1.35)</td>
<td>(2.23)</td>
<td>(-.37)</td>
<td>(1.45)</td>
<td>(-1.66)</td>
</tr>
</tbody>
</table>

\(a n = 20, b n = 21\).

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Player’s Personality

Trait aggressiveness

Figure 3 shows the effect of the level of violence in the video game and aggressiveness on the reaction to aggressive stimuli. The effect seemed to be more intense in more aggressive as compared to less aggressive participants. A $2 \times 2$ ANOVA (Aggressiveness $\times$ Level of Violence) showed a significant main effect of level of violence, $F(1, 37) = 8.72, p = .005$. However, there was neither a main effect of aggressiveness, $F(1, 37) < 1, p = .591$, nor a significant interaction between level of violence and aggressiveness, $F(1, 37) = 2.80, p = .103$.

Gaming experience

Because we assumed that the desensitization processes would be cumulative, we also analyzed the influence of participants’ gaming experience. A $2 \times 2$ ANOVA (Gaming Experience $\times$ Type of Video Game) confirmed the already known difference with respect to the response to aggressive stimuli between the low-violence ($M = -.25, SD = .23$) and high-violence ($M = .01, SD = .21$) conditions, $F(1, 23) = 9.15; p = .006$. There was no significant main effect of gaming experience, $F(1, 23) < 1, p = .822$, and no significant interaction between the two variables, $F(1, 23) = 1.28, p = .270$.

In the high-violence group, the mean for the reaction to aversive stimuli was $-.24 (SD = .30)$. The average reaction tended to be higher in the low-violence group ($M = .03, SD = .10$).
ly experienced participants reacted less strongly ($SD = .20$) than less experienced participants did ($M = .89, SD = .42$). An interaction effect of the two variables on the reaction to aversive stimuli was not found, $F(1, 23) < 1, p = .899$.

**Discussion**

This experiment examined the effects of violent video games on arousal. Unexpectedly, it revealed that participants’ heart and respiration rate decreased while they played the game. Hence, the players become more relaxed rather than more excited, and the hypothesis of an increase in general arousal due to video games was not confirmed. However, the playing period was limited to 20 min, and it may be that arousal effects appear only after a longer period of exposure as players become more familiar with the game and increase their involvement (e.g., through a stronger adoption of the first-person perspective). On the other hand, a decrease in arousal is consistent with players’ stating that they use computer games to relax (Luthman, 2008; Staude-Müller, 2008).

Turning to the impact of a higher level of violence on arousal, results show that players in the high-violence condition exhibited a greater difference in heart rate than those in the low-violence condition. But group differences were due to a greater general decrease in arousal in the low-violence group (see above). The same trend was found for respiration. Thus, the data did not support the arousal hypothesis. In particular, the relationship for heart rate was unexpected. This may be due to the way we operationalized the baseline heart rate. When planning the experiment, we expected filling out questionnaires to be a simple task requiring little effort, so that the participants would be physiologically at rest. Carnagey, Anderson, and Bushman (2007) used the same procedure and found the anticipated results regarding arousal changes. However, we suspect that arousal initially remained at an increased level in our study due to the laboratory atmosphere and the application of electrodes. A subsequent, slow habituation to this situation may have compensated for the effects of the video game. Our data showed an increase in heart rate at the beginning of the game in the high-violence group, but no such increase in the low-violence group. This may be a sign of the anticipated effect of violence level that is concealed by a general decrease in heart rate during the experiment.

Of even greater importance in this study was the question of (de-)sensitization. Emotional responses to aversive (pictures of mutilated corpses, accident victims, etc.) and aggressive stimuli (pictures of weapons, threatening situations) were assessed by measuring galvanic skin response and subjective judgments. The aversive pictures caused much weaker physiological responses in the group of participants that had been exposed to a high level of violence than in the group that played the toned down version. This supports the desensitization hypothesis. The game’s gore and slasher effects caused a hardening in the players. The skin conductance data for aggressive pictures also pointed in a specific direction: The participants who played the more violent version of the game showed a higher response to the aggressive stimuli. This can be explained by the priming of aggressive knowledge structures, which are pre-activated by the aggressive content of the video game and therefore more easily accessible. If aggressive stimuli are presented afterwards, more intense reactions occur.

An interesting finding is that aggressive as well as aversive pictures were judged to be unpleasant and exciting by both groups equally. This means that the violence in the video games exerts a different influence at various stages in the emotional processing of the stimuli. The judgment of the pictures is at least partly a cognitive process also influenced by attitudes, socially shared ideals, etc., and thus does not indicate the induced emotional state as directly as the physiological reaction does. If we had only examined the judgments, higher processes of interpretation and assessment could have masked the effects of video game violence revealed by the physiological data. This suggests that desensitization has the highest impact on behavior when an individual’s resources for higher cognitive processes are restricted (e.g., in confusing, ambivalent, and/or stressful situations).

Hence, it seems that violence in video games has different effects depending on the stimulus materials. A player becomes more sensitive to aggressive cues and less receptive to unpleasant cues. From the perspective of GAM, this is a rather unfavorable constellation. GAM predicts a higher likelihood of aggressive behavior if there is easier access to aggressive knowledge structures (cognitive component). The reduction in sensitivity for unpleasant stimuli could play a role when alternative ways of behaving are judged by their consequences. Unpleasant consequences, physical injuries, or suffering of others could be judged to be more acceptable. These results are particularly interesting in the light of the neurophysiological evidence provided by Weber, Ritterfeld, and Mathiak (2006). They measured brain activity (using functional magnetic resonance imaging) while participants were playing a violent game. When performing aggressive acts in the game, participants exhibited reduced neural activity in brain structures responsible for emotions and increased activity in areas involved in cognitive processes.

Because Anderson and Bushman (2001) also anticipated long-term consequences of prolonged consumption of media with violent content, we carried out an explorative analysis in which the sample was divided into extreme groups according to gaming experience. This showed that the more experienced players reacted less sensitively to aversive stimuli, indicating the cumulative character of emotional desensitization. There seems to be an emotional hardening due to repetitive confrontation with violence in video games. However, the present study is restricted to short-term effects.
Concerning the role of aggressiveness, previous studies have shown that it influences the impact of media violence. Bushman (1995) demonstrated this with violent movies. Frinde and Obwexer (2003) also identified aggressiveness (trait) as a moderator for the impact of violence in video games on aggressive tendencies (state). The moderating effect can be explained by stronger cognitive networks of aggressive schemata (Bushman, 1996). Priming can increase the availability of these schemata. Additional analyses in this study show at least signs that aggressiveness moderates the effect of video game violence. Participants with a high tendency toward aggression tend to react more strongly to aggressive cues than those with a lower tendency. Power restriction due to small samples and range restrictions caused by dichotomization may account for this interaction failing to attain significance.

In addition, according to selective exposure theory (Zillman & Bryant, 1985) and the uses and gratifications approach (Palmgreen, 1984), aggressiveness can be expected to increase the attractiveness of playing violent video games. In turn, the increased exposure to violent content will have negative effects on the player’s aggressiveness. This is indicated by the positive correlation ($r = .23$) between aggressiveness and gaming experience in the present study. Slater et al. (2003) have proposed a downward spiral model predicting that more aggressive individuals seek out violent media content selectively: Greater exposure to media violence (e.g., video game violence) leads to enhanced aggressiveness, particularly in those who are particularly vulnerable (because of their aggressive tendencies). By introducing this reciprocal relationship between personality and selective media exposure, the model provides a useful expansion of the GAM for the long-term consequences of media violence.

Summarizing the main results, we can state that, on the one hand, violence in video games leads to an emotional desensitization to aversive stimuli. On the other hand, it can sensitize a player to aggressive cues resulting in stronger physiological reactions. But it is still necessary to clarify under what circumstances these effects influence behavior—particularly because cognitive control is involved. Further research should examine the moderating role of aggressiveness in (de-)sensitization processes. It should also investigate the question concerning whether these relationships increase in strength as a function of gaming experience (particularly in intensive players). Answers to these questions will require research on video game violence in relevant subpopulations.

**Author Note**

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The authors gratefully thank Jonathan Harrow for native-speaker advice.

**References**


The authors gratefully thank Jonathan Harrow for native-speaker advice.
olds in Germany]. Stuttgart, Germany: Medienpädagogischer Forschungsverbund Südwest.


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Appendix

IAPS Codes

IAPS codes of aggressive pictures: 2120, 3500, 6330, 6243, 6300, 6350, 6560, and 6571; subsequently dropped from analyses: 3530, 6211.

IAPS codes of aversive pictures: 3010, 3015, 3071, 3100, 3120, 3130, 9265, and 9300; subsequently dropped from analyses: 3160, 9582.