

Virtual Driving and Risk Taking: Do Racing Games Increase Risk-Taking Cognitions, Affect, and Behaviors?

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Research has consistently shown that aggressive video console and PC games elicit aggressive cognitions, affect, and behaviors. Despite the increasing popularity of racing (driving) games, nothing is known about the psychological impact of this genre. This study investigated whether playing racing games affects cognitions, affect, and behaviors that can promote risk taking in actual road traffic situations. In Study 1, the authors found that the frequency of playing racing games was positively associated with competitive driving, obtrusive driving, and car accidents; a negative association with cautious driving was observed. To determine cause and effect, in Study 2, the authors manipulated whether participants played 1 of 3 racing games or 1 of 3 neutral games. Participants who played a racing game subsequently reported a higher accessibility of cognitions and affect positively associated with risk taking than did participants who played a neutral game. Finally, on a more behavioral level, in Study 3, the authors found that men who played a racing game subsequently took higher risks in computer-simulated critical road traffic situations than did men who played a neutral game. Theoretical and practical implications are discussed.

Keywords: racing games, risk taking, obtrusive driving, risk-related cognitions and affect, risk priming

In the last decade, the playing of video console and PC games has become very popular among young people (Gentile, Lynch, Linder, & Walsh, 2004; Kubitzki, 2005). Meanwhile, the average daily time spent playing these games even exceeds the time spent watching films and TV (Huston, Wright, Marquis, & Green, 1999). After several dramatic and murderous shoot-outs in schools, game research focused mainly on the impact of aggressive shooter games on aggression-related cognitions, affect, and behaviors (Anderson & Bushman, 2001; Anderson et al., 2004). In addition to this important research, we believe that the scope of game research must be extended to include possible detrimental influences of the driving game genre on cognitions, affect, and behaviors related to risk taking in actual road traffic. In the last few years, racing games have emerged as top sellers in the computer game industry. Within photographically realistic virtual environments (i.e., the visual game environment is extremely similar to real driving environments), players race through urban and suburban traffic. Driving actions in these games often include competitive and reckless driving, speeding and crashing into other cars or pedestrians, or performing risky stunts with the vehicle. In short,

most actions in racing games imply a very high risk of having an accident or severe crash in a highly realistic virtual road traffic environment (see, e.g., GameSpot, n.d., for a review of the game *Burnout Revenge* [EA Games]), but to date, no one knows what influence these games have on variables related to actual road traffic behavior.

Media violence research has found that aggressive video games increase aggression-related cognitions, affect, and behaviors (Anderson & Bushman, 2001; Anderson et al., 2004). Even parts of rampage killings in schools are often modeled on the game content of ego shooters (Anderson & Dill, 2000; Wikipedia, 2006; e.g., it turned out that the killers in the Columbine High School massacre played first-person shooter games excessively and, in addition, recorded a video before their rampage killing in which they stated that they were looking forward to using their shotguns just as in the game *Doom* [id Software], which is one of the earliest and most famous first-person shooters). What if players of racing games similarly model their actual road traffic behavior on their behavior during these games? For example, a controversy about racing games developed when on January 26, 2006, following a horrific accident involving two street racers that resulted in the death of a taxi driver in Toronto, the racing game *Need for Speed* [EA Games] was found in one of the suspects' cars (Wikipedia, 2006). Moreover, in the context of a focus-group study (Kubitzki, 2004), in-depth interviews of young male participants in illegal street races revealed that computer and video driving games indeed played an important role in the participants' driving-related socializations. The present research sought to determine whether a similar detrimental relationship exists between playing risk-

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oriented video racing games and variables related to risky driving behavior as exists between playing aggressive video games and variables related to aggressive behavior. In short, our studies investigated the impact of video racing games on cognitions, affect, and behaviors related to risk taking.

Video Game Research

Research on the impact of video games on psychological responses has mostly been conducted in the context of the shooter genre, which allows players to walk through highly realistic environments and brutally shoot people and “monsters.” Several studies have revealed that the playing of aggressive games elicits aggressive cognitions, affect, and behavioral responses (Anderson & Bushman, 2001; for a recent review on media violence, see also Anderson, Berkowitz, et al., 2003). This research has predominantly been performed within the theoretical context of the general aggression model (GAM; e.g., Anderson & Dill, 2000; Anderson et al., 2004; Bushman, 1998), which is based on social-cognitive research, such as the model of social information processing (e.g., Dodge & Crick, 1990), Bandura’s theory of social learning (e.g., Bandura, 1971, 1986), the social-cognitive model of media violence (Huesmann, 1986), the excitation transfer model of Zillmann (1983), and the cognitive neoassociationist model of Berkowitz (1984, 1990, 1993). Most important for our line of reasoning, Berkowitz’s (1984, 1990, 1993) model suggests that aggressive ideas promoted by violent media prime other semantically related thoughts. This priming explanation is, in turn, based on a concept derived from cognitive psychology—namely, spreading activation within a memory network (e.g., Collins & Loftus, 1975): Thoughts (e.g., those triggered by violent games) send out activation along associative cognitive pathways and, thereby, activate other associated thoughts. Accordingly, other aggression-related cognitions and ideas (not identical to those observed in the media) may also be evoked by the initial aggressive cognition or idea. Moreover, within the same associative cognitive network, thoughts are linked not only to other cognitions but also to behavioral and affective reactions (e.g., Bower, 1981). In short, with regard to GAM, exposure to media violence (e.g., aggressive video and/or PC games) acts as a priming stimulus, which can trigger several associations consisting of aggressive thoughts, expectations, beliefs, and affect related to violence and, thereby, even provide the starting point for aggressive behaviors (Anderson & Bushman, 2001, 2002; Anderson et al., 2004; Anderson & Dill, 2000; Bushman, 1998). Although Freedman (2002) concluded that research on media violence generally suffers from weak effects, the impact of violent video games on aggressive behavior has been shown to be medium (e.g., Anderson & Dill, 2000 [Study 2], found an effect size [R^2] for the impact of violent video game playing on aggressive behavior of .14). The present research transfers this line of reasoning concerning violent media to risk-promoting media content. Following social-cognitive models such as GAM, our proposal is that racing games can elicit cognitions, affect, and behaviors that might promote risk taking in real road traffic situations.

The Present Research

In contrast to shooter games, little psychological research has been carried out on street-racing and driving games, despite the

fact that the latter often contain considerable risky, harmful, and aggressive road traffic behavior such as crashing into other players or driving over pedestrians (e.g., *Burnout* [EA Games], *Grand Theft Auto* [Rockstar Games]; for reviews and detailed descriptions of these games, see, e.g., <http://www.gamespot.com>). Besides eliciting aggressive acts of reckless driving, racing games allow players to break road traffic rules, and indeed, they often reinforce this behavior. Given the observed negative impact of aggressive games on aggressive responding, might racing games also have a negative impact on cognitions, affect, and behaviors promoting risk taking in actual road traffic situations? In line with the predictions of GAM, we suggest that cognitions, affect, and behaviors related to increased risk taking could be activated (primed) by the playing of racing games. This priming process could in turn increase risk taking in real-life driving.

So far, little research has addressed this question. In a preliminary study, Kubitzki (2005, 2006), who examined 13–17-year-old boys to quantify racing game activity as well as car-related behaviors in 657 participants, found that 77% of the respondents played racing games regularly; there was a significant positive association between game-playing intensity and underage driving. Other preliminary research conducted for the German Highway Safety Research Institute by Vorderer and Klimmt (2006) reported only mixed weak and (under specific conditions) short-term effects of driving games on road safety. In sum, little research has focused on this topic, and the research that exists has mostly been often based on correlative designs or interviews. In addition, the findings of the extant research are equivocal. Thus, it is difficult to answer with certainty the question whether racing games are likely to negatively affect road traffic behavior.

Below, we present three studies investigating the impact of racing games on cognitions, affect, and behaviors positively related to risk taking in road traffic. First of all, in an attempt to replicate previous correlative findings, we asked young drivers questions on their road traffic behaviors (need to impress other people, competitive driving, cautious driving, accidents) as well as how often they played current car racing games such as *Burnout*, *Midnight Racer* (Rockstar Games), or *Need for Speed*, which are among the most popular and frequently played video racing games worldwide (Study 1). Because correlative studies cannot determine cause and effect, we directly manipulated whether participants played one of three racing games or one of three neutral (nonracing) games; the dependent variable was the accessibility of cognitions (risk-related terms and ideas) and affect (arousal, excitement) that were supposed to be associated with increased risk-taking tendencies in road traffic (Study 2). Finally, to more closely observe risk taking in actual road traffic behavior, we again had participants play either a racing game or a neutral game, and we subsequently measured risk-taking behavior in critical road traffic situations with a standardized and established computer-based reaction time measure for risk taking in road traffic (Study 3). In summary, we expected a positive association between the playing of racing games and self-reported risk promotion in real road traffic behavior (Study 1). Furthermore, we expected racing games (compared with neutral games) to significantly increase cognitions, affect, and behaviors that are supposed to promote risk taking in actual road traffic situations (Studies 2 and 3). Because men more frequently play video racing games than women (Ku-

Table 1

Correlations Between Playing of Racing Games and Different Risk-Related Road Traffic Behavior in Study 1

Participant group	Competitive road traffic behavior	Need to show impressive road traffic behavior	Cautious road traffic behavior	Power of participants' cars	Number of reported accidents	Number of tickets for norm violations
Overall ($N = 198$)	.49**	.43**	-.21**	.29**	.22**	.08
Men ($n = 106$)	.50**	.44**	-.22**	.36**	.29**	-.05
Women ($n = 92$)	.33**	.28**	-.03	.001	-.13	.29**

** $p < .01$.

bitzki, 2005), on an exploratory basis, all analyses statistically controlled for gender.

Study 1

Our aim was to collect evidence on whether the playing of racing games is associated with increased risk taking in road traffic. Individuals recruited in public places indicated to what extent they played racing games; self-reported risk taking in road traffic was measured by (a) self-reported competitive behaviors in road traffic (e.g., street racing), (b) self-reported intentions to impress others (e.g., to be admired for risk taking in road traffic), (c) self-reported attitudes toward cautious behavior in road traffic, and (d) self-reported numbers of accidents. The selection of these specific driving-related variables was made on the basis of (existing) traffic safety research, which has shown competitiveness, the desire to impress, sensation seeking, and risk-taking attitudes to be relevant for the prediction of risky driving behavior (e.g., Trimpop & Kirkcaldy, 1997). We expected consumption of racing games to be positively associated with competitive and obtrusive behavior in road traffic. Furthermore, consumption of racing games was expected to be negatively associated with cautious behavior and positively associated with the number of accidents and norm violations reported.

Method

Participants and design. One hundred and ninety-eight men and 92 women participated in this study. Participants ranged in age from 16 to 45 years (overall: $M = 23.43$, $SD = 4.65$; men: $M = 23.59$, $SD = 5.29$; women: $M = 23.24$, $SD = 3.80$).¹

Materials and procedure. Participants were recruited in public places (e.g., pedestrian zones, fast food restaurants, gas stations). They were asked whether they would be willing to participate in a study dealing with road traffic behavior. First, participants answered general questions about their driver's license ("How many months ago did you gain your driver's license?" [open question]), power of their car ("How much horsepower has your current car?" [open question]), numbers of accidents ("How many accidents have you had since you gained your driver's license?" [open question]), and numbers of tickets received for norm violations in road traffic ("How many tickets have you received since you started driving a car?" [open question]). Afterward, we constructed items (derived from previous findings on determinants of risky driving behavior; e.g., Trimpop & Kirkcaldy, 1997) that aimed to measure the most important constructs for our research question:

(a) competitive road traffic behavior, (b) the need to show impressive/obtrusive road traffic behavior, and (c) cautious road traffic behavior. Competitive road traffic behavior was measured with the following items on a scale that ranged from 0 (*I don't agree*) to 10 (*I definitely agree*): (a) "I like to participate in street races"; (b) "Comparing my driving skills with others is fun"; and (c) "There should be more street races in German cities" ($\alpha = .80$). Need to show impressive/obtrusive road traffic behavior was measured with the following items on a scale that ranged from 0 (*I don't agree*) to 10 (*I definitely agree*): (a) "I like to be admired when I overtake other cars"; (b) "Boys should impress their girlfriends by risky car driving"; and (c) "I like to drive very fast when the car is full of people" ($\alpha = .67$). Cautious behavior was measured by the following items on a scale that ranged from 0 (*I don't agree*) to 10 (*I definitely agree*): (a) "I mostly respect speed limits"; (b) "I become anxious when driving too fast"; and (c) "Sometimes I am afraid that I will have an accident" ($\alpha = .52$).

Finally, participants indicated on a scale of 0 (*never*) to 5 (*daily*) to what extent they played the racing games *Need for Speed*, *DTM Racing* (DTM), *Colin McRae Rally* (Codemasters), and *GTR Racing* (10tacle Studios) as well as other racing games. We averaged these five items to provide an indicator for the frequency of participants play racing games. After the study, participants were debriefed.

Results and Discussion

The raw correlations and associated statistics are depicted in Table 1. Table 2 presents an overview of the means and standard deviations for the measures used. Because regression procedures

¹ In the context of preliminary survey research on the racing game topic, which involved 13–17-year-old participants, Jörg Kubitzki consulted the research department of the German government's youth ministry (which studies drug consumption among young Germans, etc.). On the basis of the information provided by the ministry, no parental consent is necessary to collect data from adolescents under 18 years of age provided (a) the survey research has no economic aims, (b) the survey does not delude participants (e.g., by specific manipulations), (c) the young participants are able to understand the aim and content of the research, (d) no information is collected about the parents. In addition, from a technical perspective, adolescents have an active as well as a passive interest in car driving because, in many countries, they are allowed to drive at the age of 16. In sum, in Germany, collecting data from 16- and 17-year-old participants without a consent form signed by their parents posed no ethical problem in Study 1.

Table 2

Means and Standard Deviations (in Parentheses) for Playing of Racing Games and Risk-Related Road Traffic Behavior Measured in Study 1

Participant group	Racing game consumption	Competitive road traffic behavior	Need to show impressive road traffic behavior	Cautious road traffic behavior	Power of participants' cars ^a	Number of reported accidents	Number of tickets for norm violations
Overall (<i>N</i> = 198)	0.41 (0.78)	3.02 (2.22)	2.51 (1.71)	4.64 (1.93)	101.08 (53.84)	1.28 (2.50)	2.12 (4.69)
Men (<i>n</i> = 106)	0.63 (0.84)	3.56 (2.37)	2.82 (2.00)	4.14 (1.71)	116.44 (64.27)	1.59 (3.14)	1.58 (3.40)
Women (<i>n</i> = 92)	0.15 (0.62)	2.39 (1.84)	2.18 (1.22)	5.23 (2.00)	82.10 (27.65)	0.92 (1.36)	2.70 (5.75)

^a Values represent horsepower.

would allow us to statistically control for other potentially irrelevant (but confounded) factors (e.g., age), we ran hierarchical regression analyses to determine the effect of frequency of playing video racing games on driving-relevant variables. Therefore, we combined the four major dependent variables—competitive road traffic behavior, need to show impressive/obtrusive road traffic behavior, cautious road traffic behavior (reversed), and number of accidents reported (all $r_s = .19-.56$, all $p_s < .01$)—to form a scale of risky road traffic behavior ($\alpha = .62$). We used hierarchical regression analysis to determine potential main effects and interactions. In the first step, we included the two main effects of frequency of playing racing games, $\beta = .42$, $t(195) = 6.50$, $p < .01$, and gender, $\beta = -.18$, $t(195) = -2.72$, $p < .01$. In the second step, we included the Frequency of Playing Racing Games \times Gender interaction, which reached significance, $\beta = -.49$, $t(194) = -2.64$, $p < .01$ (this interaction remained significant [$p < .05$] when the age of participants was statistically controlled for in Step 1 of the hierarchical regression analysis), and indicates that the positive association between frequency of playing racing games and risky road traffic behavior is stronger for men than for women. The effect size of the overall model (Cohen's f^2) was .25.

Study 1 provided initial evidence that the consumption of racing games is associated with increased obtrusive and competitive road traffic behavior, reduced cautious road traffic behavior, and an increased number of reported accidents. These associations were more pronounced for male participants than for female participants. A limitation of Study 1 is that because of time restrictions and restrictions imposed by the maximum feasible questionnaire length (the study was conducted in public places), we used only self-constructed items. As a consequence, only two (competitive behavior: $\alpha = .80$; impressive/obtrusive behavior: $\alpha = .67$) of the three scales provided a good reliability coefficient. The reliability coefficient of cautious behavior ($\alpha = .52$) was rather low, and thus, future research should use standardized scales with more items to obtain higher reliabilities for this construct. Moreover, because Study 1 had a correlative design, we could not determine cause and effect. Perhaps a priori competitive or obtrusive road traffic behavior might lead to preferences for increased racing game consumption. Hence, to make a stronger causal point, we used an experimental research design in Study 2.

Study 2

Participants played either one of three racing games or one of three neutral computer games. We then measured cognitions that

are positively related to risk taking (the counterpart to aggression-related cognitions in aggression research), arousal/excitement (which has been shown in previous work to be a frequent affective consequence of positive risk priming; e.g., Guter, 2006), and positive and negative affect (to statistically control for a possible general impact of affect). On the basis of the effect of aggressive media on aggressive thoughts and affect (which are regarded as the main determinants of aggressive behavior), we expected that participants who played a racing game would have a higher accessibility of cognitions and affects (arousal/excitement) that are supposed to promote risk taking than would participants who played a neutral game.

Method

Participants and design. Eighty-three students at Ludwig-Maximilians University, Munich, Germany, volunteered to participate for experimental credit. The sample consisted of 36 women and 47 men, ranging in age from 19 to 42 years (overall $M = 23.86$, $SD = 4.40$; men: $M = 23.96$, $SD = 4.47$; women: $M = 23.72$, $SD = 4.36$). The experiment had a 2 (type of game: racing game vs. neutral game) \times 2 (gender) between-subjects design.

Materials. Six different current computer games were used. The selection of the computer games was made on the basis of attractiveness and sales rankings in different computer game magazines. Three were typical racing games (*Burnout*, *Midnight Racer*, and *Need for Speed*), and three were neutral games that contained no racing content (*Tak [THQ]*, *Crash Bandicoot [Vivendi Universal Games]*, and *Fifa 2005 [EA Games]*). All games were played on a Sony PlayStation 2 platform and a 72-in. (182.88-cm) TV screen. All racing games involved participants racing through cities against other (computer) gamers. To win, participants had to massively violate traffic rules (e.g., drive on the sidewalk, crash into other cars, drive at high speed). In contrast, neutral computer games involved participants in soccer games (*Fifa 2005*) or jump and run actions (*Tak*, *Crash Bandicoot*). The assignment of participants to games was random, each game was played by an approximately equal number of participants, and gender was approximately proportional across experimental conditions.

As dependent variables (derived from aggression research; e.g., Anderson & Bushman, 2002; Anderson, Carnagey, & Eubanks, 2003), we measured accessibility of risk-related cognitions, risk-related affect (excitement/arousal), and general positive and negative affects (to statistically control possible affect-related effects).

Accessibility of risk-promoting cognitions was measured by a homonymous decision task. This type of measure belongs to the class of implicit (aggression) measures and is based on the assumption that violent media primes (increases the accessibility of) aggression-related thoughts, affects, and scripts in implicit semantic memory (see, e.g., Anderson, Carnagey, & Eubanks, 2003). Participants were given a list of 10 words: Each word had two possible meanings (homonym), either a positively risk-related meaning (e.g., *kick*: stimulation from risky behavior such as fast driving) or a nonrisk-related meaning (e.g., to *kick* a ball in soccer). Participants were asked to define each word. We used the absolute number of risk-related homonym decisions as a dependent variable (for a complete list of the homonyms used, see Table 3). Because no homonym measure existed for the accessibility of risk-promoting cognitions in German, we had to construct this measure (and, thus, no validity or reliability coefficients are available for it at present). As a second dependent variable, we measured arousal by the adjectives (a) *aroused*, (b) *excited*, (c) *bored* (reverse coded), and (d) *experiencing a "kick"* on a scale of 0 (*not at all*) to 10 (*extremely*; $\alpha = .71$). According to the *Collins Cobuild Advanced Learner's Dictionary* (2003), "if something gives you a 'kick,' it makes you feel very excited or very happy for a short period of time" (pp. 603–604). The arousal scale was derived from research on positive risk priming by Guter (2006). Positive affect and negative affect were measured by four items each, derived from the Positive and Negative Affect Scales (PANAS; Watson, Clark, & Tellegen, 1988).

Procedure. After participants arrived in the experimental lab, they learned that the aim of our study was to test video games. They would first play a video game for 20 min and subsequently answer questions concerning the game. The experimenter explained how to play the game and observed and/or assisted for the first 5 min. Afterward, the experimenter left the lab so as to reduce social-desirability and/or demand reactions from the participants. Note that each participant played exactly one (racing or neutral) game before answering the dependent measures. This procedure was necessary because of time restrictions: Experimental experience has shown that it takes a minimum of 20 min of playing one single game before a participant is really "in" the game. So if participants had played all three racing or all three neutral games, respectively, the experimental procedure (including dependent measures) would have exceeded 1 hr, which was not possible

because of recent guidelines on the university experimental course-credit system.

After 20 min of game play, the experimenter came back and told participants that they should now answer several questions on the game. These questions covered the homonymous decision task described above (risk-promoting cognitions), arousal, and positive and negative affect. At the end of the experiment, participants were thoroughly debriefed about the real aim of the study. Special care was taken to ensure that no participant left the experimental lab with negative or risk-promoting thoughts and/or feelings.

Results and Discussion

Check for interfering effects. Participants' age, the time that had elapsed since they had gained their driver's license, and the number of kilometers normally driven in 1 yr had no significant effect on dependent variables, nor did they interact with experimental conditions. With regard to the dependent variables (risk-promoting cognitions, arousal/excitement, positive and negative affect), Tukey tests revealed no significant differences among the three (different) racing games or among the three (different) neutral video games.

Accessibility of risk-related cognitions (homonyms). Means and standard deviations are depicted in Table 4. Analysis of variance (ANOVA) data are displayed in Table 5. A 2 (game) \times 2 (gender) ANOVA revealed a significant main effect of game, indicating that participants who played a racing game ($M = 4.84$, $SD = 1.84$) exhibited a higher accessibility of risk-promoting cognitions than did participants who played a neutral game ($M = 4.03$, $SD = 1.55$).

Arousal/excitement. Means and standard deviations are depicted in Table 4. ANOVA data are displayed in Table 6. A 2 (game) \times 2 (gender) ANOVA revealed a significant main effect of game, indicating that participants who played a racing game ($M = 5.29$, $SD = 1.88$) reported a higher level of arousal/excitement than did participants who played a neutral computer game ($M = 4.28$, $SD = 2.00$).

Positive and negative affect (PANAS). A 2 (game) \times 2 (gender) \times 2 (type of affect: positive vs. negative) ANOVA with repeated measures on the last factor revealed a significant main effect of type of affect, $F(1, 78) = 153.46$, $p < .01$, Cohen's $f = 1.39$, indicating that participants experienced more positive ($M =$

Table 3
Homonyms Used in Studies 2 and 3

Homonym (in German)	Risk-related meaning	Neutral meaning
WAGEN	To dare	A car
SCHNEIDEN	To diss somebody on the street	To cut (e.g., with scissors)
KICK	To get high/excited	To kick the ball (e.g., in a soccer game)
RENNEN	A race	To sprint, to run
SPEED	To be fast (e.g., when driving a car)	A drug
TRAUEN	To dare to do something	To get married
FEIGE	To be gutless, cowardly	Fig, the fruit
RASEN	To drive with high speed	Grass, lawn
FETZEN	Driving fast	A rag
SCHLAGEN	To beat someone in a race	To hit someone in a fight

Note. Words used are homonyms in German but not in English.

Table 4
Means and Standard Deviations (in Parentheses) for Risk-Related Cognitions (Homonyms) and Arousal/Excitement as a Function of Type of Game Played and Gender in Study 2

Participant group and experimental condition	Dependent variable	
	Risk-related cognitions (homonyms)	Arousal/excitement
Men		
Racing games	4.78 (1.76)	5.43 (1.85)
Neutral games	4.15 (1.23)	4.33 (1.79)
Women		
Racing games	4.94 (2.01)	5.07 (1.97)
Neutral games	3.89 (1.85)	4.24 (2.26)

Note. $N = 83$.

5.98, $SD = 2.00$) than negative affect ($M = 1.69$, $SD = 1.58$). No further significant effects or interactions were observed.

Study 2 revealed that a higher accessibility of risk-promoting cognitions and stronger arousal/excitement was subsequently observed among racing gamers than among neutral gamers. No significant differential effect on positive and negative affect by racing games was observed. Men and women reacted similarly to racing versus neutral games. Although cognitions and affect are crucial mediators of related behaviors elicited by modern media (e.g., Anderson & Bushman, 2002; Anderson, Carnagey, & Eubanks, 2003), a shortcoming of Study 2 is that we did not measure behavior directly related to the readiness to take risks in actual road traffic situations. Hence, Study 3 focused on this matter.

Study 3

Participants played either one of three racing games or one of three neutral games. Then they worked on the Vienna Test System for risk-taking (Schuhfried, 2006), a standardized and widely accepted measure of readiness to take risks in actual road traffic situations. Finally, as in Study 2, participants' accessibility of risk-promoting cognitions was measured (homonymous task). We expected participants who played a racing game to more readily take risks in typical road traffic situations than would participants who played a neutral game. Furthermore, we expected to replicate the findings of Study 2; that is, after playing racing games, participants would have higher accessibility to positively risk-related (risk-promoting) cognitions than would participants who played a neutral game.

Table 5
Risk-Related Cognitions (Homonyms) Analysis of Variance for Study 2

Source	df	F	Cohen's f
Game	1	4.73*	0.25
Gender	1	0.14	0.01
Game \times Gender	1	0.30	0.06
Within-group error	78		

Note. $MSE = 2.99$.

* $p < .05$.

Table 6
Arousal/Excitement Analysis of Variance for Study 2

Source	df	F	Cohen's f
Game	1	4.91*	0.25
Gender	1	0.26	0.05
Game \times Gender	1	0.95	0.03
Within-group error	78		

Note. $MSE = 3.85$.

* $p < .05$.

Method

Participants and design. Sixty-eight participants (29 men and 39 women), ranging in age from 19 to 35 years (overall $M = 23.62$, $SD = 4.14$; men: $M = 24.76$, $SD = 3.87$; women: $M = 22.77$, $SD = 4.17$), participated in this study. The experiment had a 2 (type of game: racing vs. neutral) \times 2 (gender) between-subjects design.

Materials. Six different games were used. The three racing games were the same as in Study 2; the neutral games were two of those used in Study 2 (*Fifa 2005* and *Tak*) and an aggressive shooter game (*Medal of Honor* [EA Games]), included to assess possible effects of aggressive media on risk taking. Gaming consoles were identical to those in Study 2. As in Study 2, the assignment of participants to games was random, each game was played by an approximately equal number of participants, and gender was approximately proportional across experimental conditions.

The main dependent variable was a standardized and widely accepted test called the Vienna Risk-Taking Test, which is a module from the Vienna Test System (Schuhfried, 2006) and measures—on the basis of reaction times—individual willingness to take risks in road traffic. This test is mainly applied in traffic psychology and requires a computer system with a monitor to be conducted. The theoretical background for the test is provided by Wilde's (1994) theory of risk homeostasis. Participants sit in front of a computer monitor and learn that they will be confronted with 15 different videotaped risky situations in road traffic (driver's perspective), such as planned overtaking maneuvers and arrival at railroad crossings that have begun to close. First, the specific traffic situation was described verbally. Then participants saw the critical situation two times. The first time, participants were instructed only to watch the situation. The second time, they decided when they would abandon their maneuver by pressing a key. The time that elapsed between the start of the sequence and the decision to abandon it was used as the dependent variable as an indicator of risk taking (the longer the reaction time, the higher the risk taking). The whole test procedure lasted about 10 min. According to its publisher, the reliability (α) of the basic test is .92. The construct validity of the test has been shown in three independent studies (e.g., Scheiblechner, 1985). A study by Sommer, Arendasy, Schuhfried, and Litzenberger (2005) revealed that the test correctly identified 89% of accident-free drivers and drivers who had multiple accidents (criteria validity: $R^2 = .636$). Unlike the cars and traffic environments in racing games, these situations were "real" videotaped situations, not produced by computer graphics. Moreover, the task that the participants had to perform

was entirely different: Playing racing games involved using a typical video console joystick, whereas responding to the risk-taking test involved pressing a button on the computer keyboard. So the environment as well as the task facing the participants and the response action required in the risk-taking test were not so similar to the gaming environment as to make transfer inevitable and, thus, produce some kind of demand effect.

After the Vienna Risk-Taking Test, participants worked on the same material that was used in Study 2 to measure risk-related cognitions. Finally, to check for interfering effects, we asked general questions concerning driver's license, accident history, sensation seeking (Zuckerman, 1994), and enjoyment of the games (see Table 7). After the experiment, participants were debriefed and dismissed.

Results and Discussion

Check for interfering effects. Age was significantly related to risk-taking behavior ($r = .32, p < .01$) but did not interact with experimental conditions (i.e., the Game \times Gender interaction was still significant, $p < .01$, when age was statistically controlled for as a covariate). The time that had elapsed since participants gained their driver's license, the number of accidents reported, sensation seeking, and enjoyment of the games had no significant effect on risk-taking behavior, nor did they interact with experimental conditions. Tukey tests revealed that the aggressive video game did not significantly differ from the other neutral games with regard to readiness for risk taking and accessibility of risk-related cognitions. A similar picture was obtained when the same analyses were separately computed for women and men. Although the sample size was rather small (making it difficult to detect a potential difference between the aggressive shooter game and the other control games), on the basis of the present analyses, it seems unlikely that the violent shooter game had a specific aggression-mediated effect on risk-related variables and, thus, can be combined with the sample of control nonracing games.

Risk-taking behavior. Means and standard deviations are depicted in Table 8. ANOVA data are displayed in Table 9. A priori contrasts revealed that men took more risks in critical road traffic situations when they had previously played a racing game ($M = 7.54, SD = 1.34$) rather than a neutral game ($M = 6.41, SD = 1.20$), $t(64) = -2.43, p < .05$. In contrast, women's readiness for risk taking was not differentially affected by racing ($M = 5.87, SD = 1.21$) versus neutral games ($M = 6.49, SD = 1.26$), $t(64) = 1.54, ns$. Moreover, men who played a racing game took more risks than did women who played a racing game, $t(64) = 3.79, p < .01$.

Accessibility of risk-related cognitions (homonyms). Means and standard deviations are depicted in Table 8. ANOVA data are

Table 8

Means and Standard Deviations (in Parentheses) for Risk-Related Cognitions (Homonyms) and Risk-Taking Behavior (Reaction Times) as a Function of Type of Game Played and Gender in Study 3

Participant group and experimental condition	Dependent variable	
	Risk-taking behavior (reaction times in seconds)	Risk-related cognitions (homonyms)
Men		
Racing games	7.54 (1.34)	4.71 (1.77)
Neutral games	6.41 (1.20)	2.87 (1.55)
Women		
Racing games	5.87 (1.21)	4.58 (1.68)
Neutral games	6.49 (1.26)	4.35 (1.53)

Note. $N = 68$.

displayed in Table 10. A 2 (game) \times 2 (gender) ANOVA revealed a significant main effect of game, indicating that participants who played a racing game ($M = 4.64, SD = 1.69$) exhibited a higher accessibility of risk-related cognitions than did participants who played a neutral game ($M = 3.71, SD = 1.69$). This main effect was qualified by a significant Game \times Gender interaction, indicating that the impact of racing games on risk-related cognitions was more pronounced for men ($M = 2.87, SD = 1.55$ [neutral game] vs. $M = 4.71, SD = 1.77$ [racing game]) than for women ($M = 4.35, SD = 1.53$ [neutral game] vs. $M = 4.58, SD = 1.67$ [racing game]). The main effect of game was still significant when age was statistically controlled as a covariate ($p < .05$). The Game \times Gender interaction was not significant when age was statistically controlled for.

Study 3 replicated and extended the findings of the previous studies on a more behavioral level: Racing games increased readiness to take risks in critical road traffic situations as well as the accessibility of cognitions positively related to risk taking. This effect was especially pronounced for men. Women were less prone to be affected by racing games. It is interesting to note that this interaction of racing game exposure and gender was not found in Study 2. There are a number of conceivable reasons for this: For example, the realistic driving situations (i.e., the dependent variable of risk taking) experienced prior to completing the risky-cognitions task might have made women more risk averse than men, resulting in a lower availability of risk-promoting cognitions for women than men. Thus, it would be a fruitful endeavor for future research to statistically control for possible order effects of different risk-related measures as a function of gender and exposure to racing games.

Table 7

Wordings of General Questions in Study 3

Topic	Question
Driver's license	"How many months have elapsed since you gained your driver's license?"
Accident history	"How many accidents have you had since you gained your driver's license?"
Enjoyment of the games	"How much did you enjoy playing the video game in the current study?" (0 = not at all; 10 = extremely)

General Discussion

Much evidence has shown that aggressive games increase players' aggression-related thoughts and behaviors. Although it is a topic of high societal relevance, much less attention has been paid to the detrimental effects of racing games on risk-taking variables. Consistent with social-cognitive and priming explanations of media effects, the present research suggests that the playing of racing games (a) increases the accessibility of thoughts that are positively related to risk taking, (b) leads to enhanced arousal and excitement, and (c) increases risk-taking behavior in critical road traffic situations. After finding strong positive correlations between the playing of racing games and self-reported risk-taking behavior in road traffic (Study 1), we directly manipulated whether participants played racing or neutral games to determine cause and effect. After playing racing games (compared with control games), participants exhibited a higher accessibility of risk-promoting cognitions, were more aroused/excited (Study 2), and, most important, were more ready to take risks in critical (computer-displayed) road traffic situations (Study 3). Whereas racing games significantly affected risk-promoting cognitions and affect of both male and female participants (although these patterns were more pronounced for men than for women), significantly increased risk-taking behavior in critical road traffic situations was found only for male participants.

Theoretical and Practical Implications

On a theoretical level, our results support social-cognitive explanations of media priming effects. Similar to the priming effects and modeling impact of aggressive media stimuli, we have shown that "positively framed" risky media content (as provided by racing games) activates cognitions and feelings of arousal and excitement that are positively related to increased risk taking, which in turn (at least for male participants) can lead to actual increased risk taking in simulated critical road traffic situations. Hence, social-cognitive models addressing the influence of media on psychological variables, such as GAM (Anderson & Bushman, 2002), should be extended to include possible effects of risk-related media content.

An interesting but not totally unexpected finding was that, overall, female participants' risk-related responding was less strongly affected by racing games than was that of male participants. There are several possible reasons for this finding. For example, numerous studies have shown that young men are more attracted by the video game medium (e.g., Krahé & Möller, 2004), are more affected by motor sports in any respect (Kubitzki, 2004),

Table 9
Risk-Taking Behavior Analysis of Variance for Study 3

Source	<i>df</i>	<i>F</i>	Cohen's <i>f</i>
Game	1	0.70	0.11
Gender	1	6.71*	0.32
Game × Gender	1	8.11**	0.36
Within-group error	64		

Note. The Game × Gender interaction was still significant when age of participants was statistically controlled for ($p < .01$). $MSE = 1.56$.
* $p < .05$. ** $p < .01$.

Table 10
Risk-Related Cognitions (Homonyms) Analysis of Variance for Study 3

Source	<i>df</i>	<i>F</i>	Cohen's <i>f</i>
Game	1	6.75*	0.32
Gender	1	2.85	0.21
Game × Gender	1	4.10*	0.25
Within-group Error	64		

Note. $MSE = 2.65$.

* $p < .05$.

have more traffic violations and accidents (e.g., Laapotti, Keskinen, Hatakka, & Katila, 2001), and have higher sensation-seeking scores (e.g., Jonah, 1997) than do young women. These significant gender differences, which are evident in accident statistics and past research, might be explained by certain effects of socialization, with car driving and motor sports being considered a masculine matter. Furthermore, because men, in general, are more favorably inclined to risk taking (e.g., Elliott, Shope, Raghunathan, & Waller, 2006; Taubman-Ben-Ari & Findler, 2003) and more frequently play video racing games than do women (Kubitzki, 2005), risk-related cognitions, affect, and behaviors might be more strongly internalized and embedded in the male cognitive system. This, in turn, should enhance the likelihood of priming of these constructs by risk-related media stimuli (similar effects have been shown for aggressive media: participants with a trait disposition of aggressiveness respond more aggressively to aggressive media content than do participants with low dispositional aggressiveness; see, e.g., Anderson, Carnagey, & Eubanks, 2003). Finally, from a more methodological perspective, the gender difference might derive from performance differences in the racing games used. For example, in Study 3, the finding that women in the racing game condition scored lower on readiness for risk taking than did those in the neutral game condition might be attributable to a stronger feeling among women of having failed at the racing games (e.g., having more accidents or poorer score performances because of less experience with computer games), which could have made some of them more risk averse. To test this account of the observed gender differences, subsequent research should try to additionally assess participants' performance (e.g., number of accidents, score level, rankings) in racing games played. In short, future research should always statistically control for possible gender effects and, in addition, empirically examine possible reasons for the different impact of racing games on risk-related responding of women and men.

On a practical level, our results pose the question whether playing racing games leads to accidents in real-life road traffic. We demonstrated that playing racing games affects risk-taking cognitions, affect, and behaviors. Research on media violence has shown that cognitions, affect, and behavioral intentions are the most important mediators for determining effects of media content on real-life behaviors (e.g., Anderson, Carnagey, & Eubanks, 2003; Anderson et al., 2004). From traffic safety research, it is known that driving-related attitudes and intentions strongly determine driving behavior (Kubitzki, 2005; for a detailed theoretical discussion supporting this argument, see also Åberg, 2001, and de Pelsmacker and Janssens, in press, who reported a correlation of

.47 between driving attitudes [intentions] and speed violation behavior). Putting these arguments and empirical evidence together, we conclude that playing racing games could provoke unsafe driving (e.g., we found that male players of racing games reacted about 1 s later to critical road traffic situations than did male players of neutral games). To conclude, practitioners in the field of road traffic safety should bear in mind the possibility that racing games indeed make road traffic less safe, not least because game players are mostly young adults, acknowledged as the highest accident-rate group.

Limitations and Future Research

A limitation of our studies is that we only used games with road traffic (street-racing) settings. Many racing games (e.g., *Formula 1* [SCEE]) only let players drive around dedicated racing circuits without traffic and, thus, do not allow players to break traffic rules. Hence (although it is not empirically clear whether Formula 1 driving simulations are qualitatively different from the kinds of racing games used in the present research), we do not know whether similar effects of racing games on risk-related responding could be observed for the whole driving genre.

Another point to discuss is whether our dependent variables are valid indicators of real-world driving behavior. To answer with certainty whether racing games increase risk taking in road traffic, studies demonstrating a game effect on players' accident and traffic violation rates would be needed. Also, simulator studies (in which actual driving behavior, or more realistic simulated driving behavior, serves as a dependent variable) are desirable (although these measures might be even more prone to be biased by social desirability than the measure we used in the present Study 3).

Another shortcoming of Studies 2 and 3 is that participants only completed a single game before answering the dependent measures. Although this procedure was necessary because of time restrictions, the heterogeneity of the tasks (games) could possibly have resulted in effects being obscured in the present study. Future research should plan longer playing sessions (e.g., 2 hr) to permit participants to play a wider range of a specific type of game, thus preventing effects of possible heterogeneity among the stimulus material.

We have predicted and interpreted our findings solely in context of the GAM. However, one could also construct an alternative framework for the present findings that is based on the classic frustration-aggression hypothesis. That is, individuals who play street-racing games experience a variety of frustrating events (e.g., being overtaken, speeded out, or rammed by other cars), which, in turn, might lead to a higher risk acceptance by the player so as to respond aggressively to other road users. Furthermore, an increased level of desensitization for risky road traffic situations (on a more perceptual level) might also be an explanation for our present results. Because we cannot rule out these alternative accounts on the basis of the present data, it might be a fruitful endeavor for future research to investigate whether frustration-aggression theory or desensitization accounts can also be applied to explain the impact of racing games on risk-related behavior.

A further limitation of the present research concerns the role of arousal/excitement as risk-related affect. Derived from previous work (Guter, 2006), which found that risk priming (e.g., by pictures, movies, and games) systematically increases feelings of

arousal and excitement, arousal was regarded as a crucial affective difference between racing and nonracing games (and, therefore, it was used as a dependent variable rather than statistically controlled for in a pretest). However, GAM and previous violent video game research do not necessarily suggest that arousal will be higher in high-risk games (violent or racing) than in the games used for comparison. The level of arousal strongly depends on the characteristics of the games used for comparison; one can choose very arousing but nonrisky games. Therefore, several studies of violent video games have preselected violent and nonviolent games that were equally arousing so that the potentially observed differences in aggressive responding could be clearly attributed to violent game content rather than to differences in arousal. Future research on the impact of racing games on risk-related road traffic behavior should use similar pretests and research designs.

Finally, on the basis of the present studies, we cannot determine whether the effects reported are only short-term or are also long-term effects. Theoretically, Kubitzki (2005) argued that racing games reward illegal, reckless, competitive, and aggressive driving, and thus—given that the average initial age for playing racing games is 10—this systematic reward could have a long-lasting influence on the development of attitudes and habits in driving. Moreover, the positive correlation between frequency of playing racing games and risk taking in real-life driving situations further suggests that there might be a long-term connection. However, future research should indeed investigate whether it is possible to extrapolate from short-term effects of racing games to possible long-term effects by using a longitudinal study design.

References

- Åberg, L. (2001). Attitudes. In P.-E. Barjonet (Ed.), *Traffic psychology today* (pp. 119–136). Norwell, MA: Kluwer Academic.
- Anderson, C. A., Berkowitz, L., Donnerstein, E., Huesmann, L. R., Johnson, J., Linz, D., et al. (2003). The influence of media violence on youth. *Psychological Science in the Public Interest*, 4, 81–110.
- Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science*, 12, 353–359.
- Anderson, C. A., & Bushman, B. J. (2002). Human aggression. *Annual Review of Psychology*, 53, 27–51.
- Anderson, C. A., Carnagey, N. L., & Eubanks, J. (2003). Exposure to violent media: The effects of songs with violent lyrics on aggressive thoughts and feelings. *Journal of Personality and Social Psychology*, 84, 960–971.
- Anderson, C. A., Carnagey, N. L., Flanagan, M., Benjamin, A. J., Eubanks, J., & Valentine, J. C. (2004). Violent video games: Specific effects of violent content on aggressive thoughts and behavior. *Advances in Experimental Social Psychology*, 36, 199–249.
- Anderson, C. A., & Dill, K. E. (2000). Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology*, 78, 772–790.
- Bandura, A. (1971). Social learning theory of aggression. In J. G. Knutson (Ed.), *Control of aggression: Implications from basic research* (pp. 201–250). Chicago: Aldine-Atherton.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.
- Berkowitz, L. (1984). Some effects of thoughts on anti- and prosocial influence of media events: A cognitive neoassociationist analysis. *Psychological Bulletin*, 95, 410–427.

- Berkowitz, L. (1990). On the formation and regulation of anger and aggression. *American Psychologist*, 45, 494–503.
- Berkowitz, L. (1993). *Aggression: Its causes, consequences, and control*. Philadelphia: Temple University Press.
- Bower, G. H. (1981). Mood and memory. *American Psychologist*, 36, 129–148.
- Bushman, B. J. (1998). Priming effects of violent media on the accessibility of aggressive constructs in memory. *Personality and Social Psychology Bulletin*, 24, 537–545.
- Collins, A., & Loftus, E. (1975). A spreading activation theory of semantic memory. *Psychological Review*, 82, 407–428.
- Collins Cobuild advanced learner's dictionary (4th ed.). (2003). London: Collins.
- de Pelsmacker, P., & Janssens, W. (in press). The effect of norms, attitudes and habits on speeding behavior: Scale development and model building and estimation. *Accident Analysis & Prevention*.
- Dodge, K. A., & Crick, N. R. (1990). Social information-processing bases of aggressive behavior in children. *Personality and Social Psychology Bulletin*, 16, 8–22.
- Elliott, M. R., Shope, J. T., Raghunathan, T. E., & Waller, P. F. (2006). Gender differences among young drivers in the association between high-risk driving and substance use/environmental influences. *Journal of Studies on Alcohol*, 67, 252–260.
- Freedman, J. L. (2002). *Media violence and its effect on aggression: Assessing the scientific evidence*. Toronto, Ontario, Canada: University of Toronto Press.
- GameSpot. (n.d.). Burnout Revenge for PlayStation 2 [Review]. Retrieved August, 2006, from <http://www.gamespot.com/ps2/driving/burnoutrevenge/review.html?q=burnout>
- Gentile, D. A., Lynch, P. J., Linder, J. R., & Walsh, D. A. (2004). The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance. *Journal of Adolescence*, 27, 5–22.
- Guter, S. (2006). *Risikoverhalten und Massenmedien: Der Einfluss von Risikodarstellungen in den Massenmedien auf risikobezogene Kognitionen, Emotionen und Verhaltensweisen* [Risky behavior and mass media: The impact of risky media content on risk-related cognitions, emotions, and behaviors]. Taunusstein, Germany: Driesen.
- Huesmann, L. R. (1986). Psychological processes promoting the relation between exposure to media violence and aggressive behavior by the viewer. *Journal of Social Issues*, 42, 125–139.
- Huston, A. C., Wright, J. C., Marquis, J., & Green, S. B. (1999). How young children spend their time: Television and other activities. *Developmental Psychology*, 35, 912–925.
- Jonah, B. A. (1997). Sensation seeking and risky driving: A review and synthesis of the literature. *Accident Analysis & Prevention*, 29, 651–665.
- Krahé, B., & Möller, I. (2004). Playing violent electronic games, hostile attributional style, and aggression-related norms in German adolescents. *Journal of Adolescence*, 27, 53–69.
- Kubitzki, J. (2004). *Von der Playstation auf die Autobahn: Auto-Tuning, illegale Auto-Rennen und reckless driving* [From Playstation to German Freeway: Car-tuning, illegal car-racings, and reckless driving] (Report Vol. 03/04). Berlin, Germany: Verkehrstechnisches Institut der Deutschen Versicherer.
- Kubitzki, J. (2005). Zur Problematik von Video-Rennspielen [The problem of video racing games]. *Zeitschrift fuer Verkehrssicherheit*, 3, 135–138.
- Kubitzki, J. (2006, July). *Video driving games and traffic safety—A matter of concern? Results from a questionnaire survey in 13–17-year-old male adolescents*. Paper presented at the 26th International Congress of Applied Psychology, Athens, Greece.
- Laapotti, S., Keskinen, E., Hatakka, M., & Katila, A. (2001). Novice drivers' accidents and violations—A failure on higher or lower hierarchical levels of driving behaviour. *Accident Analysis & Prevention*, 33, 759–769.
- Scheiblechner, H. (1985). Psychometric models for speed-test construction: The linear exponential model. In S. E. Embretson (Ed.), *Test design: Developments in psychology and psychometrics* (pp. 219–244). New York: Academic Press.
- Schuhfried, G. (2006). *Wiener Testsystem* [Vienna test system]: Vienna Risk-Taking Test. Vienna, Austria: Author.
- Sommer, M., Arendasy, M., Schuhfried, G., & Litzenberger, M. (2005). Diagnostische Unterscheidbarkeit unfallfreier und mehrfach unfallbelasteter Kraftfahrer mit Hilfe nichtlinearer Auswertungsmethoden [Diagnostic discernibility of accident-free and nonaccident-free drivers with nonlinear analysis methods]. *Zeitschrift für Verkehrssicherheit*, 51, 82–86.
- Taubman-Ben-Ari, O., & Findler, L. (2003). Reckless driving and gender: An examination of a terror management theory explanation. *Death Studies*, 27, 603–618.
- Trimpop, R., & Kirkcaldy, B. (1997). Personality predictors of driving accidents. *Personality and Individual Differences*, 23, 147–152.
- Vorderer, P., & Klimmt, C. (2006). *Zum Einfluss von Computerspielen mit Fahrzeugbezug auf das Fahrverhalten junger Fahrer: Abschlussbericht an die Bundesanstalt für Straßenwesen* [The influence of vehicle-related computer games on the driving behavior of young drivers: Final report to the Federal Highway Research Institute (BAST)]. Hannover, Germany: Hochschule für Musik und Theater.
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54, 1063–1070.
- Wikipedia. (2006). *Video game controversy*. Retrieved August, 2006, from http://en.wikipedia.org/wiki/Video_game_controversy
- Wilde, G. J. S. (1994). *Target risk: Dealing with the danger of death, disease and damage in everyday decisions*. Toronto, Ontario, Canada: PDE.
- Zillmann, D. (1983). Cognition–excitation interdependencies in aggressive behavior. *Aggressive Behavior*, 14, 51–64.
- Zuckerman, M. (1994). *Behavioural expressions and biosocial bases of sensation seeking*. Cambridge, England: Cambridge University Press.

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