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Predicting Young Drivers' Car Crashes: The Role of Music Video Viewing and the Playing of
Driving Games. Results From a Prospective Cohort Study

Kathleen Beullens & Jan Van den Bulck

Abstract

Objective: The aim of the study is to examine whether the playing of driving games and the viewing of music videos during adolescence predict crash involvement in emerging adulthood.

Method: A prospective cohort study ($N=471$) with a 5-year interval was used to measure adolescents' gender, media use, personality characteristics (baseline measurement), and crash involvement (follow-up). At baseline measurement (2006), respondents were 17 or 18 years old and did not yet have their driver's license. Data were analyzed by means of logistic regression analyses and the calculation of attributable risks.

Results: Respondents who watched music videos at least several times a week ($OR=4.319$) or respondents who played drive'em up games at least a few times a month ($OR=3.125$) had a heightened chance of being involved in a car crash five years later, even after controlling for their total media exposure, gender, and personality characteristics. Implications for prevention are discussed.

Keywords: adolescents, car crashes, emerging adults, media effects, music videos, video games

Predicting Young Drivers' Car Crashes: The Role of Music Video Viewing and the Playing of Driving Games. Results from a Prospective Cohort Study

Introduction

According to the National Center for Health Statistics, motor vehicle crashes are the leading cause of death among people under 33 years of age in the United States. In terms of the years of life lost, motor vehicle crashes are ranked third among causes of death (Subramanian, 2005). This means that, after cancer and heart diseases, motor vehicle crashes are classified third if the age at which the deaths occur is taken into account. In other countries around the world, too, traffic crashes take a tremendous toll on human life. Worldwide each year about 40,000 young people under 25 die from road traffic injuries (Toroyan & Peden, 2007). The global economic cost of traffic crashes is estimated to be \$518 billion per year. The social cost of traffic injuries is even higher, as around the world many people are coping with the death or disability of a family member or friend (World Health Organization, 2004).

The high incidence rate of traffic crashes among young people can be explained by several factors. First, they have less driving experience. Research has indicated that young drivers often fail to use routine safety operating practices (such as a visual search prior to making left turns) and do not succeed in adequately identifying potentially dangerous situations. Compared to more experienced drivers, they detect hazards less quickly and efficiently (Deery, 1999; McCartt, Mayhew, Braitman, Ferguson, & Simpson, 2009; McKnight & McKnight, 2003). Secondly, it has been argued that young drivers (especially males) have a tendency to engage in a variety of unsafe driving behaviors such as speeding, reckless driving, and joy riding (Clarke, Ward, & Truman, 2005; Harré, Brandt, & Dawe, 2000). This has been explained by the fact that they have a higher risk acceptance while driving and seem to have more confidence in their own driving skills (De Craen, Twisk, Hagenzieker, Elffers, & Brookhuis, 2011; Deery, 1999).

Shope and Bingham (2008) identified a framework of several factors contributing to teen crashes including driving ability (such as knowledge and skills), developmental factors (such as psychosocial and emotional factors), behavioral factors (such as antisocial behavior), personality factors (such as sensation seeking, aggression), demographics (such as gender, age), the perceived environment (such as cultural norms, peer norms), and the driving environment (such as time of day). The present study focuses on one of the elements of what Shope and Bingham called *the perceived environment*.

In particular, this study examines the role of the media (music videos and driving games) in young drivers' crash involvement. The media can be seen as an important shaper of cultural values and perceptions. As Shope and Bingham (2008) have argued, the media promote images of risky driving behavior such as speeding, joy riding, and performance driving. Thus they help shape young driver's perceptions of the dangers associated with driving, their perceptions of their own crash risk, and their perceptions of the chances of getting injured or killed in a traffic crash (Shope & Bingham, 2008). Other scholars have also emphasized the importance of cultural socialization in young drivers' risk-taking (Arnett, 1995; Harré, 2000) and have expressed the need for research into the relationship between media use and reckless behavior (Arnett, 1995; Reinhardt-Rutland, 2007).

Theoretical Framework

Research into the relationship between media and risk-taking behavior has been conducted from a variety of theoretical perspectives. Within communication sciences, scholars have used cultivation theory as a theoretical framework (Beullens, Roe, & Van den Bulck, 2008, 2011). Gerbner and colleagues' (Gerbner & Gross, 1976; Gerbner, Gross, Morgan, & Signorielli, 1986; Gerbner, Gross, Morgan, Signorielli, & Shanahan, 2002) cultivation hypothesis regarded television as an important source of socialization and information for its viewers. Cultivation theorists believe that there is a discrepancy between what is shown on television and the social reality. It is expected that, through long term exposure to this television

world, heavy viewers develop perceptions and attitudes in line with what is shown on television. Thus cultivation effects refer to the “independent contributions television viewing makes to viewer conceptions of social reality” (Gerbner et al., 2002, p. 47). Although cultivation theory originally discussed television effects, this theory has also been successfully applied in the context of video game effects (Van Mierlo & Van den Bulck, 2004; Williams, 2006). From the beginning, cultivation effects have been linked to perceptions of risk (see Gerbner et al.’s work on risk ratios) (Gerbner et al., 1977). While most cultivation research has assumed that exposure to violent entertainment raises perceptions of risk, it may be hypothesized that exposure to (glorified) risky driving is associated with perceptions of lower risk.

Social cognitive theory (Bandura, 2002) also expects media use to influence risk behavior and describes the processes through which such an effect might be governed. In general, social cognitive theory states that human behavior is determined through the dynamic interaction of personal factors, behavior, and environmental influences, such as the media (Bandura, 2002; Pajares, Prestin, Chen, & Nabi, 2009). Media exposure may affect behavior through a process called vicarious or observational learning. More specifically, according to the theory, such learning occurs through the processes of attention, retention, production, and motivation. In order to learn vicariously, one must be exposed to a particular behavior and this behavior must be retained in memory. This process depends on symbolic coding, cognitive organization and skills, and symbolic rehearsal (Pajares et al., 2009). The process of production entails that the symbolic representation of the observed behavior must be translated into action. Lastly, motivational processes will determine whether the observed behavior will be enacted. This motivation depends on outcome expectancies generated by feedback on one’s own behavior or observed feedback on other’s behavior (Bandura, 2002; Pajares et al., 2009).

Following cultivation theory and social cognitive theory, there are several reasons why observational learning may occur through the playing of driving games or the viewing of music television. First, risk-taking is a manifest part of the content in both genres. Although little is

known about the actual portrayal of risky driving in music videos, music videos (and song lyrics) have been widely criticized for their risk-glorifying content (Fischer, Greitemeyer, Kastenmüller, Vogrincic, & Sauer, 2011). Research has indicated that several health risk behaviors such as smoking, alcohol use, the use of illicit drugs, violent behavior, and risky sexual behavior are frequently portrayed in music videos (DuRant, 1997a, DuRant, Rich, Emans, Rome, & Allerd, 1997b; Gruber, Thau, Hill, Fisher, & Grube, 2005; Sherman & Dominick, 1986; Smith & Boyson, 2002; Sommersflanagan, Sommersflanagan, & Davis, 1993; Tapper & Thorson, 1994). Moreover, the risk-takers in music videos are often popular artists who may act as role models for their viewers (Gruber et al., 2005). As argued by DuRant et al. (1997a,b), risk behavior in this genre is often legitimized, trivialized, and glamorized. Exposure to these images may desensitize viewers and change their perception of what is socially acceptable (Bandura, 2002; DuRant et al., 1997a).

It has also been argued that video games positively depict different forms of risk-taking (Beullens et al., 2008; Fischer et al., 2011). Risky driving behavior is an important part of the content of some video game genres. Two genres in particular warrant special attention regarding traffic crashes, namely racing games and drive'em up games. In racing games, fast vehicles compete against each other. The aim of the racing game is to finish first and win the race. In drive'em up games points can also be gained by running into other cars or pedestrians. Finishing first is not an absolute requirement to win this kind of game. In both genres, gamers must engage in one or another form of risky driving behavior (e.g., speeding in the case of racing games or reckless driving in the case of drive'em up games) in order to be able to win the game. Thus, risky driving is highly rewarded within the game context. Playing these games might also function as a kind of symbolic rehearsal of risky driving behavior, especially for young people with no or limited driving experience.

Second, both music television and driving games are very popular with adolescents in Europe (Beentjes, Konig, & Kreszewski, 2008) as well as in the United States (Kaiser Family

Foundation, 2003) and among both sexes (Lenhart et al., 2008; Malliet, 2007; Van Mierlo & Van den Bulck, 2004). A recent study (Lenhart et al., 2008) showed that 97% of the teens reported playing video games. More than 50% of the adolescents in the study reported playing video games at least three to five times a week (Lenhart et al., 2008). Although adolescents appeared to play many different kinds of game genres, racing games were the most popular. Seventy-four percent of the teens reported playing this genre (Lenhart et al., 2008). The high popularity of music television and driving games implies that most adolescents are regularly exposed to the risk-behaviors portrayed in these genres.

Third, given that the goal of both genres is entertainment, risky driving is associated with positive feelings in both genres. For instance, Hansen and Hansen (2000) have reported that listening to music has been found to induce pleasurable mood states and reduce feelings of anxiety. Following Slovic and colleagues' (2007) affect heuristic, these positive affective feelings might guide judgment and decision making, and thereby affect behavior, e.g. risk taking (Slovic, Finucane, Peters, & MacGregor, 2007). Rhodes and Pivik (2011) recently examined the roles of positive affect and risk perception in risky driving. Their survey of a sample of teen and adult US drivers indicated that gender and age differences in risky driving behavior are attributable to differences in affect and risk perception. Boys and younger drivers appear to enjoy risky driving more and perceive it as less dangerous compared to female and older drivers. Conversely, the smaller the risks associated with risky driving are perceived to be and the greater the positive affect toward driving, the higher the likelihood of engaging in traffic-related risk-taking (Rhodes & Pivik, 2011).

Fourth, music videos and driving games have specific attributes which make it more likely that these genres have an effect on those exposed to them compared to other media genres. In comparison with movie viewing or television watching, video game playing is physically much less passive. Players are physically more actively involved in playing a video game. In order to successfully complete the game, they must actively engage in risky driving

(through the manipulation of the game character). This requires a higher level of involvement in and attention to the content of these games. Compared to traditional media, video games also provide more interaction because players can actively participate in shaping the game (Grodal, 2000). For instance, in racing games, the player can choose which team he or she is part of, with which car he or she would like to race, on which racing circuit, etc. In addition, driving games take place in a virtual environment that is very realistic graphically (Grodal, 2000; Williams, 2006). The racing tracks used in the games often represent exact simulations of existing race circuits (e.g., India's Buddh international circuit in *F1 2011*) and teams, which is likely to make the racing game experience even more realistic.

Music videos have been a subject of scholarly attention since their emergence on television in the eighties. However, in line with what Wallis (2011) has argued, music videos are potentially even more pervasive nowadays given that they can also be accessed via YouTube and other viewing platforms such as mobile phones. Furthermore, peer groups are often formed around specific musical preferences. As such, listening to music is important for the construction of both a self-identity and a group-identity (Hansen & Hansen, 2000).

Following social cognitive theory and cultivation theory, exposure to music videos and the playing of driving games may result in traffic-related risk-taking. However, this view differs significantly from what is argued in problem behavior theory (PBT). Jessor and Jessor (1977) have argued that some forms of risk-taking co-occur and form a cluster of problem behaviors or a problem behavior syndrome. Jessor and Jessor (1977) distinguish between three systems of psychosocial influence: the personality system, the perceived environment system, and the behavior system. Together these three systems prohibit or foster problem behavior such as risky driving. According to PBT, deviant behaviors totally different in nature may co-occur (without one causing the other) because they share a similar meaning for the adolescent. Therefore one single cause might incite different forms of risk-taking, such as risky driving, binge drinking, and smoking behavior. Following PBT, it might be possible that media such as music video

viewing and the playing of driving games co-occur with risky driving, because they share a similar meaning for the person engaging in these behaviors. As such, they may all be regarded as part of a cluster of problem behaviors. This viewpoint does not regard media use as an exposure variable or as the cause of a specific behavior. This idea of media use as part of the cluster of problem behaviors is closely related to what other scholars have argued. In his theory of media delinquency, Roe (1995) has proposed that certain forms of antisocial behavior are clustered together and are related with media use, without media being the cause of the problem behavior. Krcmar and Greene (2000) left the classic media effects perspective by considering television viewing as a system-level variable. They found some support for the existence of a cluster of problem behaviors and showed that there is a relationship between exposure to certain television content (violent television drama, realistic crime shows) and participation in various risk-taking behaviors.

The Present Study

In the present study, a prospective cohort study with a 5-year interval was used in order to determine whether music television viewing and the playing of driving games during adolescence predict traffic crash involvement five years later. To our knowledge, this study is among the first to examine the direct relationship between particular forms of media use and crash involvement. Although authors who have tried to develop an integrated framework to explain young drivers' crash involvement have mentioned the importance of including cultural factors such as the media (see above), we have only found one study that specifically looked at video game playing and crash involvement (Fischer, Kubitzki, Guter, & Frey, 2007, study 1). However, in that study crash involvement was used as an indicator of risky driving and was combined with other variables into one construct.

A limited number of studies have focused on the relationship between media use and traffic-related risk-taking (Beullens et al., 2008, 2011, 2012; Beullens & Van den Bulck, 2008; Fischer et al., 2007, 2009, 2011; Fischer, Guter, & Frey, 2008). Studies that examine this

relationship are mostly correlational or experimental in nature, and are focused on risk-taking inclinations as the dependent construct (Beullens et al, 2008; Beullens & Van den Bulck, 2008; Fischer et al., 2007, 2008). Only a few studies looked at self-reported risky driving behavior (Beullens et al., 2011, 2012; Fischer et al., 2011). The present study extends this emerging line of research by focusing on crash involvement as the dependent construct and by examining the long term relationship between media use and crash involvement. The few longitudinal studies that have been conducted in this research area have used self-reported risky driving as a dependent construct and have considered the relationship between media use and risk-taking over a 2 year time period (Beullens et al., 2011, 2012). However, it is unsure whether this risk-taking behavior will transfer into crash involvement, and it is unknown whether this relationship also exists when longer measurement intervals are considered. Therefore, it is the main aim of the present study to examine whether music television viewing and video game playing at baseline predicted crash involvement five years later.

Given the specific attributes of music videos and driving games (see above) and given the fact that previous research has reported relationships between media use, risk-taking inclinations (e.g., Beullens et al., 2008; Beullens & Van den Bulck, 2008; Fischer et al., 2008), and behavior (Beullens et al., 2011, 2012; Fischer et al., 2007), we expected that:

H1: Music video viewing during adolescence is a positive predictor of car crash involvement in emerging adulthood.

H2: Driving game playing during adolescence is a positive predictor of crash involvement in emerging adulthood.

To examine whether both driving game playing and music video viewing explain a different part of the variance in crash involvement and to examine which of both is the best predictor of crash involvement, both variables were entered into one model. Heavy viewing of music videos may just be a consequence of heavy overall viewing. Similarly, heavy playing of

driving games may be a correlate of heavy overall gaming. Total amount of video game playing and overall TV viewing were therefore entered as controls.

In a second phase of the analyses, we tested whether the relationship between media use and crash involvement remained significant when certain variables, which have been shown to be related with both media use and risk-taking/crash involvement, were entered into the analyses. Gender, sensation seeking, and aggression were therefore entered into the regression as potential confounders. Research has indicated that male drivers are more frequently involved in traffic crashes than female drivers (Jelalian, Alday, Spirito, Rasile, & Nobile, 2000). Sensation seeking, defined by Zuckerman (1994, p. 27) as “the seeking of varied, novel, complex, and intense sensations and experiences and the willingness to take physical, social, legal, and financial risks for the sake of such experiences,” and aggression has also been shown to be important predictors of risk-taking in traffic and traffic crash involvement (Arnett, 1996; Arnett, Offer, & Fine, 1997; Constantinou, Panayiotou, Konstantinou, Loutsiou-Ladd, & Kapardis, 2011; Dahlen & White, 2006; Gulliver & Begg, 2007; Jonah, 1997; Sümer, 2003).

In line with what Valkenburg and Peter (forthcoming) recently argued, sensation seeking and aggression might have multiple roles in the relationship between media use and crash involvement. There is a consistent body of literature indicating that personality characteristics predispose media use (Ferguson et al., 2008; Krcmar, 2009; Lemmens & Bushman, 2006; Perse, 1996; Valkenburg & Peter, forthcoming). For instance, Lemmens and Bushman (2006) indicated that aggressive and less empathic boys were most attracted to video games. Ferguson et al. (2008) found that aggressive young people have a preference for different game content than youngsters scoring low on aggressiveness. Perse (1996) analyzed high and low sensation seekers' television viewing. Her results showed that high sensation seekers prefer different formats than low sensation seekers do. More specifically, high sensation seekers had a preference for arousing media content such as music programs and action adventure programs. Slater and Rasinski (2005) also emphasized this selective attention and concluded that media

effects on social risk judgments are part of a larger social process. Media use appeared to partly mediate the relationship between particular individual differences such as sensation seeking and social risk judgments. Similarly, Slater, Hayes, and Ford (2007) found the relationship between sensation seeking and risk judgments to be mediated through adolescents' attention to accident and crime news. Accordingly, media use might be conceptualized as the mediator of the relationship between personality characteristics and crash involvement.

H3: Music television viewing and driving game playing mediate the relationship between personality characteristics and crash involvement.

However, these personality characteristics (as well as gender) might also function as moderators of the relationship between media use and crash involvement (Krcmar, 2009; Valkenburg & Peter, forthcoming). Previous research has identified trait aggressiveness as a moderator in exploring media effects (Krcmar, 2009). Examining the moderating role of sensation seeking, aggression, and gender is particularly relevant in the present research because it allows researchers to examine which individuals are more susceptible to these media processes than others. Accordingly, it allows researchers to then predict more accurately which youngsters are particularly at risk. Through examining the different role of these variables, the present study tries to provide more insight into the mechanisms and processes underlying these relationships.

H4: Gender, aggression, and sensation seeking moderate the relationship between media use and crash involvement.

Because it is the aim of this article to examine whether media use *predicts* traffic crash involvement (and under which conditions this occurs), a prospective cohort study with a 5-year follow-up was used. There are several reasons why a 5-year interval between the two measures was used. First, from a prevention point of view, it is interesting to be able to forecast which adolescents are more likely to be involved in a traffic crash. Prevention campaigns could then be directed at future risk-takers before they put themselves and others at risk. From this viewpoint,

the earlier future risk-takers are identified, the better. Second, most of the respondents of the baseline measurement were 17 or 18 years old, had not yet obtained their driver's license, and were still in high school. Five years later, they had entered the stage of what Arnett (1998) has called emerging adulthood. Emerging adults are in a phase between adolescence and young adulthood. They have left high school, and are pursuing higher education, or entering their first jobs. It is an age characterized by identity explorations and instability. Young people in this stage frequently change studies, jobs, partners, and housing. They live on their own or together with friends for the very first time. Compared to adolescents, they are much freer from parental control. Emerging adulthood is also a period in which many different futures remain open. This range of possibilities, together with the diminished social control, means that risk behavior, including risky driving, is very prevalent among emerging adults (Arnett, 1998, 2005). Automobile crash rates among this group are nearly as high as among late teenagers. In spite of this, however, they remain an understudied group in risk research (Arnett, 1998).

Method

Sample

Data were gathered in a prospective cohort study with a 5-year interval. The baseline measurement was administered in 2006. First, a stratified random sample of 20 secondary schools in Flanders (Belgium) was selected from the official list of secondary schools. Next, these schools were contacted with the request to cooperate in a large-scale study on the relationship between media use and risk-taking among adolescents. When a school agreed to cooperate, all students from the fifth and sixth year were included in the sample. This selection procedure was repeated until 15 schools agreed to participate in the study.

Research assistants visited the selected schools to administer the questionnaires. The study was presented to the respondents as a study of leisure activities and traffic. In total, 2,193 pupils filled out a standardized, self-administered questionnaire including measures of personality characteristics, video game playing, television viewing, and crash involvement.

Sixty-five point two percent of the students were boys, 34.8% were girls. Forty-one point seven of the respondents were born in 1988, 36.5% in 1989 ($M=1988$, $SD=.93$), thus a large majority of our respondents were 17 or 18 years old at baseline measurement. In Belgium, a definitive driver's license can only be obtained at the age of 18. A large majority (91.3%) of the respondents in the first wave did not yet have their driver's license during data collection. As a result, their crash involvement was not assessed in the questionnaire at baseline.

The strict confidentiality of the respondents' answers was assured before as well as after the completion of the questionnaire. Next, if they were willing to take part in the follow-up study, respondents were asked to provide their email and home address. In total, 89.5% agreed to do so and provided their home address, 71.3% provided their e-mail address.

In 2011, five years after the baseline measurement, respondents were contacted again, by email, with the request to take part in the second wave of the study and fill out the online survey. In total, three reminder emails were sent to all participants who had not yet completed the online survey. A letter was sent to the home address of those who did not respond to these emails and to those who had not provided their email address. This letter included a link to the online survey. Again, three reminders were sent, resulting in a total response of 652 questionnaires. Thus, 30% of the respondents who completed the first wave took part in the second wave of the study. As the objective of the study is to predict traffic crash involvement, only participants with a permanent driver's license at follow-up were included in the analyses. This was a subsample of 471 emerging adults. Forty-two point nine percent were 22 years old, 42.1% were 23 years old, 14.7% were 24, or older and one respondent was 21 years old. Fifty-three point nine per cent were males, 46.1% females. Of the respondents, 53.5% pursued higher education, 1 respondent was still in high school, 40.5% were employed, and 3.5% were in search of employment.

We checked whether adolescents from the original sample differed significantly from those who completed both questionnaires. This analysis showed that females were more likely

to have completed both measurements ($X^2=62.38$, $df=1$, $p<.001$). Furthermore, respondents of both waves watched music videos less often (wave 1 only: $M=4.53$, $SD=1.78$; both waves: $M=4.15$, $SD=1.96$; $t(1265,51)=3.92$, $p<.001$), watched less television in general (wave 1 only: $M=20.66$, $SD=11.16$; both waves: $M=18.42$, $SD=9.90$; $t(1497)=4.24$, $p<.001$), played computer games less often (wave 1 only: $M=15.92$, $SD=12.78$; both waves: $M=12.54$, $SD=10.74$; $t(785,92)=4.08$, $p<.001$), and racing and drive'em up games less often (racing games: wave 1 only: $M=2.04$, $SD=1.88$; both waves: $M=1.86$, $SD=1.69$; $t(1070,76)=5.16$, $p<.001$; drive'em up games: wave 1 only: $M=2.52$, $SD=1.99$; both waves: $M=1.91$, $SD=1.82$; $t(1061,96)=5.51$, $p<.001$). Furthermore, they also scored lower on intensity seeking (wave 1 only: $M=2.60$, $SD=0.51$; both waves: $M=2.36$, $SD=0.52$; $t(1557)=9.04$, $p<.001$) and aggression (wave 1 only: $M=2.36$, $SD=0.53$; both waves: $M=2.13$, $SD=0.51$; $t(1488)=8.15$, $p<.001$). No differences were found concerning novelty seeking.

Measures

Video game playing was measured by means of a list of various content types. Respondents were asked (a) "how often do you play racing games on a circuit such as *Gran Turismo*, *Ridge Racer*, *MotoGP*,..." (b) "Drive'em up games such as *Driver*, *Carmageddon*, *Burnout*, *Need for Speed*,...". Response categories were (0) never, (1) a few times a year, (2) about once a month, (3) a few times a month, (4) about once a week, (5) a few times a week, (6) (almost) every day (see Beullens et al., 2011). For the clarity of the analyses these variables were recoded into three categories: light players (respondents who played these games a few times a year at most), moderate players (those who played these games a few times a month at most), and heavy players (respondents playing at least once a week).

Total number of hours of video game playing per week was assessed by means of three questions: "How long (hours and minutes) do you play computer or video games" (a) "on a regular weekday (Monday through Thursday)?", (b) "on a regular Friday?", (c) "on a weekend day (Saturday or Sunday)?".

Respondents were asked to indicate “How often do you watch music videos?”: (0) never, (1) a few times a year, (2) about once a month, (3) a few times a month, (4) about once a week, (5) a few times a week, (6) (almost) every day. This variable was also recoded into three categories: light viewers (respondents who watched music videos once a month at most), moderate viewers (those who watched music videos between once a month and once a week), and heavy viewers (respondents watching at least several times a week). These categories differ slightly from those for video game playing because video game playing was less popular among the adolescents in the sample. Using the same categories would have led to a very limited number of respondents in the highest category. Therefore, this variable was recoded slightly differently.

Following Eggermont (2006), the total number of hours of television viewing per week was measured with a timeline for each day of the week. The timelines began at 7 a.m. and ended at 4 a.m. Each line consisted of 42 checkboxes, each representing a half hour of possible television viewing time. Respondents were asked to mark the period(s) of time at which they normally watch TV on that particular day. The total number of hours of television viewing per week was computed by counting the marked checkboxes for each respondent and dividing the result by two.

Respondents completed measures on two validated scales for measuring personality characteristics, namely Arnett’s Inventory of Sensation Seeking (AISS) (Arnett, 1994; Haynes, Miles, & Clements, 2000) and Buss and Perry’s (1992) Aggression Questionnaire. In their comparison of the AISS and Zuckerman’s Sensation Seeking Scale Form V, Haynes and colleagues (2000) concluded that a modified version of AISS provides a more appropriate measure of sensation seeking. The original version of this 20-item scale has two subscales, namely intensity seeking and novelty seeking. We tried to replicate the factor structure of the original scale by extracting two factors with a principal components analysis with oblique rotation. Six items of the original scale had a factor loading greater than .40 and loaded on the

intensity factor (Cronbach's $\alpha = .63$), and five items on the novelty factor (Cronbach's $\alpha = .64$). The items were averaged for each of these subscales.

Next, physical aggression (9 items) was measured with the Aggression Questionnaire (Buss & Perry, 1992). The reliability analysis yielded a Cronbach's α of .82. Responses for both personality characteristics ranged from (1) do not agree at all, (2) do not agree, (3) agree to (4) totally agree.

Finally, respondents indicated their gender: (1) male, (2) female. All of these predictor variables were assessed at baseline measurement. Our dependent construct, traffic crash involvement, was assessed at follow-up. Respondents indicated whether they (as drivers) had already been involved in a traffic crash with damage to the bodywork of the car: (0) no, (1) yes.

Analyses

To examine the relationship between media use and crash involvement, explorative logistic regression analyses and attributable risks were calculated. Mediation and moderation analyses were conducted with PROCESS, a tool for observed variable mediation, moderation and conditional process modeling (Hayes, 2012). All analyses were conducted with SPSS 19.0.

Results

Descriptive Statistics

Of the respondents, 19.7% were categorized as light music video viewers (baseline measurement). Thus, they reported watching this genre once a month at most. Twenty-one point four percent watched music videos at most once a week, and 58.9% watched music videos at least a few times a week. Video game playing appeared to be less popular among the adolescents in our sample (baseline measurement). Fifty-one point nine percent of the respondents played drive'em up games a few times a year at most. Twenty-four point three percent played a few times a month at most and 23.7% at least once a week. Similar frequencies were found for playing racing games: 53.0% played a few times a year at most, 26.9% a few times a month at most, and 20.1% at least once a week. Thirty-nine point three percent of the

emerging adults with a driver's license in the sample had already been involved in a traffic crash.

TABLE 1: ABOUT HERE

The strengths of the correlations between the measures of media use and the control variables are shown in Table 1. Most Pearson correlation coefficients in the table ranged between $r=.10$ and $r=.30$, which represent small to medium relationships (Field, 2005, p. 111). However, the novelty factor of sensation seeking was not significantly associated with most other variables. This variable only correlated significantly with the total amount of game playing and the total amount of television viewing. Unsurprisingly, racing game playing and drive'em up game playing were strongly correlated ($r=.62, p<.001$)(see Table 1).

Hypotheses Testing

First it was tested whether adolescents' use of particular media predicted their car crash involvement (H1, H2). It was hypothesized that the playing of racing and drive'em up games, on the one hand, and music video viewing on the other hand, were positive predictors of emerging adults' car crash involvement, even after controlling for total hours of television viewing a week and the total amount of video game playing a week. The results largely confirmed these hypotheses. As displayed in Table 2, music video viewing and drive'em up game playing in adolescence predicted later crash involvement. Contrary to our expectations, racing game playing was not a significant predictor (Model Chi-square=27.637, $df=8, p<.001$; Nagelkerke $R^2=.149$; Hosmer and Lemeshow test: Chi-square: 8.195, $df=8, p=.415$).

TABLE 2: ABOUT HERE

In particular, for those who played drive'em up games a few times a month at most, the odds of being involved in a traffic crash were three times the odds of those who never played this genre of video games ($OR=3.340$). Similarly, the odds of being involved in a traffic crash almost tripled for respondents who played these games at least once a week ($OR=2.949$). Furthermore, compared to light viewers, the odds of heavy music video viewers being involved in a traffic crash were more than four times higher ($OR=4.266$). No significant difference was found between moderate and light music video viewers. These relationships remained significant after controlling for total amount of television viewing and total amount of video game playing, which indicates that the viewing of these genres added something beyond the total exposure to these media.

Next, the question of whether the relationship between music television viewing and drive'em up game playing, on the one hand, and crash involvement, on the other hand, remained when gender and certain personality characteristics were controlled for was examined. This model is shown in Table 3.

TABLE 3: ABOUT HERE

Although this model appeared to explain a significant part of the variance in our dependent construct (Model Chi-square=36.762, $df=10$, $p<.001$; Nagelkerke $R^2=.206$; Hosmer and Lemeshow test: Chi-square: 6.329, $df=8$, $p=.610$), some of the predictors were found to be non-significant. Contrary to what was to have been expected based on the literature, neither of the sensation seeking factors made a significant contribution to our model, nor did the measure of physical aggression or the respondents' gender. After entering these constructs in the model, moderate drive'em up game playing ($OR=3.125$), heavy drive'em up game playing ($OR=2.269$), heavy music video viewing ($OR=4.319$) and the total amount of television viewing ($OR=.954$) still significantly predicted emerging adults' crash involvement.

Given the size of the odds ratios, and in line with Willoughby, Chalmers, and Busseri's (2004) guidelines, it could be argued that adolescents who played drive'em up games more than a few times a year had a considerably increased chance of being involved in a traffic crash. A similar conclusion was made concerning adolescents who watched music videos at least a few times per week. In sum, the results of the present study indicate that the use of specific media in adolescence predicts later crash involvement.

Mediation and Moderation Analyses

The statistical methods outlined in Hayes (2009, 2012) and Preacher and Hayes' (2008) were followed to assess multiple mediator models (H3). In total, three models were calculated, one for each predicting construct, namely aggression, intensity seeking, and novelty seeking. Crash involvement at time 2 was entered as a dependent construct in each model, and music television viewing, drive'em up game playing, and racing game playing were entered as mediators operating in parallel. In each model gender, total television viewing, total game playing, and the remaining personality characteristics were included as statistical controls. These analyses revealed that there was no significant total effect on crash involvement for both intensity and novelty seeking. Following the 95% bias-corrected bootstrap confidence intervals no evidence was found for music video exposure, drive'em up game playing, or racing game playing as mediators of this relationship. A total effect of aggression on crash involvement was found (effect= 1.7660, *S.E.*=8338, *Z*=2.1182, *p*<.05), but 95% bias-corrected bootstrap confidence intervals indicated that the media variables were not significant mediators of this relationship.

Moderation analyses were also conducted in line with Hayes' (2012) advice. For each media variable (music television, drive'em up games, racing games), it was tested whether the relationship between media use and crash involvement was moderated separately by gender, intensity seeking, novelty seeking, and aggression. The statistical controls were included in all

of these models. This means that, in total, 12 models were estimated to conduct the moderation tests. In sum, these analyses showed no evidence for gender, aggression, or sensation seeking as moderators of the relationship between media use and crash involvement. Thus, no evidence was found for hypothesis 4.

Attributable Risks

Finally, attributable risks were calculated in order to determine the extra crash risk occurring among different categories of driving game players and music video viewers. Attributable risk or risk difference is a measure often used in epidemiology. Essentially, it is the difference between incidence rates in exposed and non-exposed groups (Webb, Bain, & Pirozzo, 2006). In the present study, this measure is used to calculate the difference in crash involvement between different groups of adolescents, namely light, moderate, and heavy drive'em up game players and light, moderate, and heavy music video viewers.

These analyses indicated that light drive'em up game players had a 34.3% chance of being involved in a car crash. This percentage rose to 53.7% and 52.5% for the moderate players and heavy players of these games respectively. Thus, the attributable risk or the excess crash risk occurring from playing drive'em up games more than a few times a year was 19.4%. Adolescents watching music videos once a month at most had a 21.1% chance of being involved in a car crash 5 years later. For moderate viewers who watched this television content once a week, this chance increased to 39.8%. Heavy music video viewers even had a 44.2% chance of being involved in a car crash. This means that compared to light viewers, moderate viewers had 18.8% more chance of being involved in a car crash, and for heavy viewers this chance increased by 23.1%. These percentages represent the potential reduction in crash involvement if these respondents had decreased their music video viewing to watching once a month at most.

Discussion

Frequent video game players and music television viewers are mostly adolescents or emerging adults. This same group is overrepresented in traffic crashes (Toroyan & Peden, 2007). Therefore, it is remarkable that the relationship between these variables has not received much attention in the literature. In the present study, a prospective cohort study with a 5-year interval was used in order to examine whether adolescents' playing of driving games and their viewing of music videos predicted their self-reported car crash involvement five years later.

The results indicated that the use of these media genres during adolescence indeed predicted crash involvement in emerging adulthood. This relationship remained after controlling for gender, sensation seeking, aggressiveness, the total amount of television viewing, and the total amount of video game playing. More specifically, for those who played drive'em up games a few times a month at most, the odds of being involved in a traffic crash were three times higher than for those who never played this game genre. In other words, adolescents playing drive'em up games more than a few times a year had a 53.7% chance of being involved in a car crash five years later, while this was 34.3% for emerging adults playing less in their adolescence.

The relationship was even stronger for music video viewing. Compared to light viewers, the odds of being involved in a crash were four times higher for heavy music video viewers. In other words, light music video viewers had a 21.1% chance of being involved in a crash, rising to 44.2% for the heavy viewers of this genre.

The present study has extended the research in this domain by being among the first to indicate that the use of particular media in adolescence predicts emerging adults' crash involvement. It was examined whether personality characteristics can be considered as the predictors of crash involvement with the different types of media use as the mediators of this relationship. Furthermore, it was investigated whether these personality characteristics and

gender can be conceptualized as moderators of this relationship. However, no support was found for these additional analyses.

Following effects theories such as cultivation theory and social cognitive theory, media use might cause traffic crash involvement (Bandura, 2002; Gerbner & Gross, 1976; Gerbner et al., 1986). As indicated in the literature review, health risk behaviors are often portrayed in the media. It has been argued that the exposure to these images might affect adolescents' perceptions and behavior. Thus, the frequent viewing of these genres might lead to traffic-related risk-taking behavior, which in turn might predict traffic crash involvement.

Several processes (not included in the present study) might explain such a relationship. The association between media and risk-taking behavior may be the result of an underestimation of the risks involved, an overestimation of the social acceptability of such behavior (which would be cultivation effects), or by making risky driving look fun, cool, or desirable (which would be social modeling). Consistent with dual process explanations of risk-taking, Rhodes and Pivik (2011) reported that both risk perceptions and positive affect predict risky driving behavior and that both function as independent processes. Thus, lower estimations of the risk associated with risky driving and a greater liking of it appeared to predict risky driving. Moreover, among those especially at-risk of being involved in a traffic crash, namely young and male drivers, positive affect appeared to predict risk-taking better than risk-perception. Among women and older drivers, on the other hand, risk-perceptions appeared to be the best predictor of risk-taking (Rhodes & Pivik, 2011).

Interestingly, both risk perception and positive affect have also been associated with media use. Music video viewing as well as driving game playing are both forms of entertainment in which driving is associated with positive feelings (see above). Risk perception has been found to be related to music television viewing in previous research (Beullens & Van den Bulck, 2008). Thus, positive affect and risk perception might also mediate the relationship

between media use and crash involvement. This explanation implies that media might cause risk-taking through risk perception and positive affect.

Several models trying to clarify the routes through which media may affect behavior have identified similar processes (Valkenburg & Peter, forthcoming). For instance, Buckley and Anderson (2006) argued in their general learning model that, in the short term, both person and situational variables influence three types of interrelated states, namely cognition, affect, and arousal. In turn, these states are believed to affect the processes of appraising a given situation and deciding what to do in that particular game situation. This results in a certain outcome within the game context and may result in reinforcement or punishment. It is believed that this outcome feeds back into the cycle and affects future cognition, affect, and arousal. By continuing this cyclical process, it is believed that game playing may affect behavior in both the short and the long term. In this general learning model, as well as in other media-effect theories, the content of the media plays a central role (Buckley & Anderson, 2006; Gentile et al., 2009).

However, problem behavior theory provides a totally different explanation for why music video viewing and drive'em up games might be related with crash involvement. Problem behavior theory (Jessor & Jessor, 1977), proposes that the use of particular media might be regarded as a form of risk-taking. That is, the use of particular media and engagement in traffic related risk-behavior might share similar meanings for adolescents, and might occur simultaneously. Following this line of reasoning, music videos and driving games, which at first sight seem to be very distinct media, might co-occur with risky driving because they all share a similar meaning for the adolescent and serve the same function. In this second view, media use is not a cause of risk taking, but an early marker of later problem behaviors. It is considered to be part of a lifestyle in which risk-taking is present. Several authors have argued that risky driving is part of a particular lifestyle (Bina, Graziano & Bonino, 2006; Moller, 2004) and media use, too, has been found to be related with risk-taking and is considered to be an important lifestyle aspect (Klein et al., 1993; Krcmar & Greene, 2000). In this respect, the

relationship between media use and risk-taking is considered to be more of a dynamic process and not simply a linear cause of risk-taking. The present study is unable to determine which of these theories explains the relationship between media use and crash involvement. In line with previous research, it might be suggested that media content might explain this relationship (Beullens et al., 2011). However, we do not know to what extent risky driving is depicted in music television, and contrary to drive'em up game playing, we did not find a relationship between racing game playing and crash involvement. Regarding the latter, it has to be noted that the difference between racing games and drive 'em up games is that racing games involve fair play and following racing rules, while drive 'em up games involve (and reward) deviant driving behaviors.

It follows that the present study is unable to establish the direction of causality. Although the relationship between media use and crash involvement remained significant after controlling for certain personality characteristics and gender, the possibility remains that other variables (and measures) that were not included in the study could explain the reported association.

Nevertheless, the results remain interesting and very relevant from the perspective of prevention. They indicated that drive'em up game playing and music video viewing are markers for emerging adults' traffic crash involvement, because they predicted crashes among adolescents without a driver's license. They even (partly) predicted traffic crashes five years before they occurred. This implies that, irrespective of the question of whether exposure to these genres actually causes traffic crashes, adolescents who play a lot of drive'em up games or watch a lot of music videos form an important group to target with prevention campaigns (even before they obtain their driver's license). After all, the results show that those frequently exposed to these specific genres in adolescence have higher chances of being involved in a crash. Moreover, the findings provide knowledge on the living environment of these adolescents, their lifestyle, and interests. Future risk takers appear to have a preference for certain media content. Thus, they can be reached through these media, and messages targeted at this group should

adhere to the styles used in these media. Consequently, video games constitute an interesting channel for future prevention campaigns. Other scholars have also proposed that “serious games” (i.e., video games primary designed for other purposes than merely entertainment) might be a good medium for prevention purposes (Fitzgerald et al., 2008; Peng, 2009; Wiemeyer, 2010). For the same reasons that negative, unintended effects might result from games, they might also be successful in fostering desired behavior. Unfortunately, research in this domain is scarce. In cases where these games have been used in the context of prevention, this was mainly in the area of physical exercise (Fitzgerald et al., 2008; Wiemeyer, 2010) and nutrition (Baranowski et al., 2003, 2011; Peng, 2009).

Despite its merits, the present study has several limitations. First, the causality between media use and traffic crash involvement cannot be determined. However, this was not the aim of the present study. The focus lies on media use as a marker for traffic crash involvement. The fact that future risk-takers can be reached through their media use before they put themselves and others at risk is in itself an important finding.

Second, even though the study was not designed as a test of social cognitive theory, the results of the study seem to be in line with what has been proposed in that theory (Bandura, 2002). Future research should therefore be designed to test this theory in relationship to media use and crash involvement. Furthermore, we analyzed personality characteristics as both predictors of media use and moderators of the relationship between media use and crash involvement. Yet the analyses did not support our hypotheses with regard to the dual role of these constructs. Future research should try to deepen our understanding of conditional media effects and the processes to which media are related to crash involvement (see Lang & Ewoldsen, 2010). Third, despite our efforts to maximize response rates, the response rate of the follow-up survey was only 30%. This is in line with what has been achieved in other online surveys, and is unsurprising given the large time lag between both measurements (Millar & Dillman, 2011; Sax, Gilmartin, & Bryant, 2003). The analysis of the non-response indicated that

it seems to have been the more moderate respondents who participated in both waves. Other researchers have noted that some subgroups (e.g., males) are more difficult to follow in longitudinal research and that these groups often also display more risk-taking behavior (Lorant, Demarest, Miermans, & Van Oyen, 2007). This loss to follow-up may actually have worked against finding support for the hypotheses, as the group most likely to be affected and most exposed was more likely to drop out. If more of the heavily exposed and most likely to be affected had remained in the sample, it is possible that the relationships would have been even stronger. More research is needed to see whether the relationships found in the present study hold true in other samples.

Fourth, all self-reported crashes were included in the analyses. Unfortunately, we do not know how many of these crashes were accidents in which the respondent was at-fault. In line with Elliott, Waller, Raghunathan, Shope, and Little (2000) it might be hypothesized that *at-fault* crashes are more indicative of risk-taking behavior. Therefore, future research should examine whether media use is a better predictor of at-fault crashes compared to other crashes. Finally, self-report measures were used to assess the constructs in our study. Although research has indicated that respondents often find it difficult to remember how many car crashes they were involved in (af Wahlberg, 2003), we believe that this counts to a lesser extent for the respondents in our sample. As they were all young drivers, the period which they had to consider in order to complete the questionnaire was not very long compared to older, more experienced drivers. Furthermore, the number of crashes that were reported in the present study correspond to Belgian crash statistics indicating that 1 in 3 males have a car crash within one year after obtaining their driver's license (Beullens, 2009).

The results of the present study show that media use in general and the use of specific genres in particular are important variables to consider when examining the predictors of traffic crash involvement. Future studies should examine these relationships in greater depth, try to

clarify whether this relationship is causal, and determine through which mediators and moderators it occurs.

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Table 1

Correlations between the media and control variables, and measures' range, mean scores and standard deviation

	1.	2.	3.	4.	5.	6.	7.	8.
1. Racing games	Range: 2, $M=1.67$, $SD=0.79$							
2. Drive'em up games	.619**	Range: 2, $M=1.71$, $SD=0.82$						
3. Total game playing	.143*	.259**	Range: 64.50, $M=12.23$, $SD=10.40$					
4. Total television viewing	.228**	.275**	.428**	Range: 65, $M=18.49$, $SD=9.78$				
5. Music video viewing	.181**	.178**	.049	.269**	Range:2, $M=2.39$, $SD=0.80$			
6. Physical aggression	.171**	.279**	.163*	.167**	.118*	Range: 2.56, $M=2.13$, $SD=0.51$		
7. Novelty (sensation seeking)	-.107	-.082	-.150*	-.178**	.006	-.051	Range:3, $M=2.69$, $SD=0.55$	
8. Intensity (sensation seeking)	.150**	.225**	.102	.103*	.092	.926**	-.053	Range:2.67 $M=2.13$, $SD=0.49$

**Correlation is significant at .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed). For a complete description of the constructs, see Method, Measures.

Table 2

Logistic regression model with crash involvement at follow-up as dependent variable and drive'em up games, racing games and music television viewing as predictors

	<i>B</i>	<i>S.E.</i>	<i>Df</i>	<i>Sig.</i>	<i>Exp(B)</i>
Drive'em up games			2	.006	
Drive'em up games(1)	1.206	0.411	1	.003	3.340
Drive'em up games(2)	1.082	0.458	1	.018	2.949
Racing games			2	.620	
Racing games(1)	-0.254	0.400	1	.526	0.776
Racing games(2)	-0.420	0.458	1	.359	0.657
Music videos			2	.003	
Music videos(1)	0.797	0.495	1	.107	2.218
Music videos(2)	1.451	0.455	1	.001	4.266
Total television viewing	-0.045	0.018	1	.011	0.956
Total game playing	-0.002	0.015	1	.875	0.998
Constant	-0.831	0.465	1	.074	0.436

Model Chi-square=27.637, $df=8$, $p<.001$; Nagelkerke $R^2=.149$; Hosmer and Lemeshow test: Chi-square: 8.195, $df=8$, $p=.415$

For a complete description of the constructs, see Method, Measures.

Table 3

Logistic regression model with crash involvement at follow-up as dependent variable and media use and control variables as predictors

	<i>B</i>	<i>S.E.</i>	<i>Df</i>	<i>Sig.</i>	<i>Exp(B)</i>
Drive'em up games			2	.008	
Drive'em up games(1)	1.139	0.382	1	.003	3.125
Drive'em up games (2)	0.819	0.415	1	.048	2.269
Music videos			2	.007	
Music videos(1)	0.802	0.531	1	.131	2.229
Music videos(2)	1.463	0.490	1	.003	4.319
Total television viewing	-0.047	0.020	1	.019	0.954
Total game playing	-0.013	0.019	1	.489	0.987
Gender	0.552	0.396	1	.163	1.737
Intensity (sensation seeking)	-0.750	0.868	1	.388	0.472
Novelty (sensation seeking)	-0.275	0.298	1	.357	0.760
Physical aggression	1.491	0.884	1	.092	4.441
Constant	-2.454	1.511	1	.104	0.086

Model Chi-square=36.762, $df=10$, $p<.001$; Nagelkerke $R^2=.206$; Hosmer and Lemeshow test: Chi-square: 6.329, $df=8$, $p=.610$

For a complete description of the constructs, see Method, Measures.