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Self-concept as a risky driver: Mediating the relationship between racing video games and on-road driving violations in a community-based sample

Evelyn Vingilis [a,*], Zümrüt Yıldırım-Yenier [a], Peter Fischer [b], David L. Wiesenthal [c], Christine M. Wickens [d], Robert E. Mann [d], Jane Seeley [a]

[a] Population and Community Health Unit, Schulich School of Medicine and Dentistry, The University of Western Ontario, Canada
[b] Department of Psychology, University of Regensburg, Germany
[c] Department of Psychology, York University, Canada
[d] Centre for Addiction and Mental Health, Canada

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ABSTRACT

Purpose: The mediating relationship of self-conceptions as a risky driver on self-reported driving violations was examined for players of "drive'em up" and "circuit" racing video games using an Internet survey of automobile and racing club members. Structural equation modelling (SEM) tested Fischer et al. (2012) extended socio-cognitive model on the effects of risk-glorifying media on cognitions and actions.
Method: An Internet questionnaire was developed and relied upon validated instruments or questions derived from previous surveys. Driver club members were asked about: (1) their frequency of video game playing, (2) self-perceptions as a risky driver and (3) self-reported driving violations. SEM was performed to examine mediating effects of racing video game playing on self-reported driving violations.
Results: Playing "drive'em up" video games positively predicted risky self-concept ($\beta = .15$, $t = 2.26$), which in turn, positively predicted driving violations ($\beta = .73$, $t = 8.63$), while playing "circuit racing" games did not predict risky self-concept, although risky self-concept did predict driving violations ($\beta = .72$, $t = 8.67$).
Conclusions: Self-concept as a risky driver mediated the relationship between racing video game playing and self-reported driving violations for "drive'em up", but not for "circuit racing" video games. These findings are congruent with Fischer and colleagues' experimental model that self-concept as a reckless driver mediated the relationship between racing video game playing for "drive'em up", but not for "circuit racing" games and risk-taking behavior in a video of road traffic scenarios.

1. Introduction

Drivers engaging in risky practices, specifically driving violations ("deliberate infringement of some regulated or socially accepted code of behaviour") (Iversen, 2004, p. 136; Reason, Manstead, Stradling, Baxter, & Campbell, 1990), are a serious concern because of their increased probability of traffic collisions and fatalities (Cooper, 1997; Parker, Reason, Manstead,

* Corresponding author.
E-mail address: evingili@uwo.ca (E. Vingilis).

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& Stradling, 1995; Rajalin, 1994). Risky driving can be due to person factors, situation-environmental factors, or an interaction of the two. Person factors emphasize causes originating within the individual, whereas situation-environmental factors focus on behavioral influences external to the individual (e.g., reinforcement contingencies operating in the environment) (Vingilis & Mann, 1986). Research on risky driving has examined person factors, such as socio-demographic (e.g., age, gender) (Rhodes & Pivak, 2011; Özkan & Lajunen, 2006), personality (e.g. sensation seeking) (Jonah, 1997; Jonah, Thiessen, & Au-Yeung, 2001), neurodevelopmental changes and cognitive processes (e.g. prefrontal cortex maturation) (Keating & Halpern-Felsher, 2008; Steinberg, 2008). Recent analyses employing cross-sectional, longitudinal, experimental and meta-analytic socio-psychological research demonstrated that situational factors, such as media portrayals of risk-glorifying driving, including racing video games, also contributes to risky driving inclinations, behaviors and negative outcomes (Beullens, Roe, & Van Den Bulck, 2008; Beullens, Roe, & Van den Bulck, 2011; Fischer, Greitemeyer, Kastenmüller, Vogrincic, & Sauer, 2011; Fischer, Guter, & Frey, 2008; Fischer, Kubitzki, Guter, & Frey, 2007; Fischer, Vingilis, Greitemeyer, & Vogrincic, 2011; Fischer et al., 2009; Hull, Draghici, & Sargent, 2012; Vingilis, Seeley, Wiesenthal, Wickens et al., 2013). These findings are of concern because video games are a popular activity, particularly among young people, with racing video games being the most popular (Lenhart et al., 2008).

Various social-cognitive theories have been used to explain the relationship between racing video game playing and risky driving. They are based on the premise that video games are behavioral simulators in which "[b]ehavioral scripts rewarded in the game then serve to guide behavior in the real world" (Hull et al., 2012, p. 245). Initial experimental, laboratory research by Fischer, Kubitzki, Guter, and Frey (2007), Fischer et al. (2008) and Fischer et al. (2009) examined the applicability of the General Aggression Model (GAM) and General Learning Model (GLM) to risk-glorifying racing video games to determine whether racing video game playing activates increased risk-taking as found with the negative effects of violent video games. They hypothesized that racing video games can "prime" cognitions, affect and behaviors (Fischer et al., 2007). Participants were randomly assigned to one of two experimental conditions; participants who played a racing game demonstrated significantly more risk-related cognitions and affect compared to participants who played a non-racing (neutral) game. Likewise, in their second experimental study, Fischer et al. (2007) found that participants who played a racing game were significantly more likely to engage in subsequent risk-taking in a video of road traffic scenarios (Vienna Risk-Taking Test-Traffic) compared to participants who played a neutral game. Subsequent studies found that compared to neutral video games, risk-glorifying racing video games increased risk-promoting attitudes and self-conceptions as a risky driver which partially mediated risk-taking behavior in a video of road traffic scenarios (Fischer et al., 2008, 2009).

Fischer et al. (2012) have expanded on the GAM and GLM by including self-conception as an extended component of the models. They suggest that exposure to risk-glorifying media, such as racing video games, can affect participants' self-conception through different processes related to situational reward cues, active versus passive media consumption and social norms and risk habituation. Situational reward cues refer to the rewarding of certain risk-taking portrayals ending in a positive outcome which elicits pleasant emotions. Video game playing is based on reward cues and two genres of racing video games exist that reward different behaviors. "Drive'em up" racing games (e.g., Grand Theft Auto, Need for Speed) reward driving and other violations. Players of these games drive at high speed through normal urban areas in the presence of other vehicles, engaging in aggressive and risky lane changes, reckless overtaking manoeuvres into oncoming traffic, intentionally driving over pedestrians, crashing purposely into other vehicles (see content described on racing games, such as Grand Theft Auto, Burnout, Need for Speed). "Circuit racing" games (e.g., Formula 1, Gran Turismo, Ridge Rager, MotoGP) depict Formula 1 (F1) style, closed track racing rewarding skillful, accurate driving to win the race, rather than traffic violations, purposeful crashes or reckless driving, although clearly speeding is also a component of this game genre.

The second process affecting self-conception is participation requiring active control of the video game character, as opposed to passively viewing videos. Players identify with their game characters (Fischer, Kastenmüller & Greitmeyer, 2010) and active participation in racing video game playing resulted in larger risk-taking effects than passively observing racing video game playing or mere exposure (Fischer, Greitemeyer et al., 2011; Fischer, Vingilis et al., 2011; Fischer et al., 2009). Fischer et al. (2009), Fischer, Vingilis et al. (2011) and Fischer, Greitemeyer et al. (2011) suggested that self-concept as a risky driver should be more common for participants who play "drive'em up" racing games than for participants who play either "circuit" racing or non-racing games. Self-conceptions as a risky driver was also only found for the participants who played the "drive'em up" games, but not for the participants who played the "circuit" or non-racing games (Fischer, Greitemeyer et al., 2011; Fischer, Vingilis et al., 2011; Fischer et al., 2009). Mediational analyses found a significant effect for self-conceptions as a risky driver on risk-taking behavior in a video of traffic scenarios. The third process to affect self-conception through racing video game playing is changes to social norms and risk habituation; if racing video game players are taking excessive "risks" in their game playing without negative physical or social consequences, they may learn that excessive risky driving is positive, rewarded and socially accepted (Fischer et al., 2012).

As Fischer, Greitemeyer et al., 2011 stated: "the racing game effect requires the player to perceive that he or she is actively involved in breaking traffic rules, which leads to the self-perception that one is a reckless driver, and thus finally to more risk taking"(p. 703). Although experimental studies found that self-conception as a risky driver was a mediator of risk-taking behavior in a video of traffic scenarios among participants playing "drive'em up" compared to "circuit" racing video games (Fischer et al., 2009), no research is available on whether this laboratory tested relationship occurs in the real world where risk has the potential for serious consequences. Recent community-based research has found an association between "drive'em up" racing games and self-reported risk-taking in the roadway environment, but not between "circuit" racing games and self-reported risk-taking driving (Vingilis, Seeley, Wiesenthal, Mann et al., 2013). No community-based research has

examined these putative mediating effects using structural equation modelling (SEM). Moreover, Fischer et al.'s (2009) scales of driver self-concept were not validated measures. Thus, this study utilizes validated measures of driver self-concept to explore whether driver self-concept mediates the relationship between "drive'em up" games and risky driving, and to examine the associations among these variables, using a community-based sample.

The present study examined the mediating relationship of self-conceptions as a risky driver on self-reported driving violations for players of "drive'em up" and "circuit racing" video games, using an Internet survey of automobile and racing club members. Because "drive'em up" games reward driving violations, we were interested in self-reported driving violations as the outcome variable. However, we were also mindful that our study design was correlational and could determine neither causality nor directionality of variables.

Automobile and racing enthusiasts were chosen because enthusiasts represent an information rich sample. Automobile racing has been ranked as the most popular sport in the world (Gnuschke, 2004). In 2002, more than 2 billion tickets were sold for automobile racing events throughout the world (Gnuschke, 2004). In the United States, attendance is highest for automobile racing compared to other sports (Gnuschke, 2004). Moreover, research has found that automobile and racing enthusiasts generally have higher rates of driving violations (Armstrong & Steinhardt, 2006; Leal, 2010; Tranter & Warn, 2008; Vingilis, Seeley, Wiesenthal, Mann et al., 2013; Warn, Tranter, & Kingham, 2004). Current statistics from informal sources indicate that automobile and racing enthusiasts are majority males with racing enthusiasts being somewhat younger than automobile enthusiasts status (Goodyear, 2015; Hamer & Hamer, n.d.; Performance Research, 2013; Reynolds, 1996; Ryval, 2014; Sass, 2014; WISSOTA Auto Racing, 2015; Worldata., n.d.). For example, the 2015 Formula Car Challenge indicated that their "road racing audience" were 70% male; 64% were between 24 and 44 years of age (median age = 36.5) (Goodyear, 2015). NASCAR fans were reported to be 78% male with an average age of 42 (Performance Research, 2013), while WISSOTTA fans were reported as 78% male, with 29% 19–25 years of age, 28% 26–35 years old, 19% 36–45 years old and 9% 46 years of age and older (WISSOTA Auto Racing, 2015). Yet, classic automobile enthusiasts have been reported to have an average age of 55 with 75% 46 years of age and older (Hamer & Hamer, n.d.) or median age of 55 (Ryval, 2014), or median age of 56, with 58% between the ages of 51 and 70 (Sass, 2014). Worldata (n.d.) reported that the automobile collector enthusiast was 60% male with average age of 59.

2. Method

2.1. Measures

The expert panel method was used for the development of the Internet survey (Survey Monkey-based questionnaire) following the principles of good questionnaire design (Krishner & Guyatt, 1985; Weiler, Sliepcevich, & Sarvela, 1993). Eleven traffic safety researchers and/or car enthusiasts engaged in item generation, review and reduction of a list of questions taken from validated instruments or questions from other surveys. The survey had numerous revisions, and was both pretested and pilot-tested. The following variables were included in the questionnaire:

(1) *Racing video games played* – included two 6-point Likert-style scale questions (1 = never to 6 = almost every day) that measured frequency of playing "drive'em up" games (e.g., Grand Theft Auto, Carmageddon, Burnout, Need for Speed) and "circuit" racing games (e.g., Formula 1, Gran Turismo, Ridge Rager, MotoGP). Higher scores reflected more self-reported game playing.

(2) *Risky driver self-conception* – (i) The Driver Thrill Seeking Scale (DTSS) is an eight item 7-point Likert-style scale (1 = strongly disagree to 7 = strongly agree). Based on research conducted by Matthews, Desmond, Joyner, Carcary, and Kirby (1997), cited in Stradling, Meadows, and Beatty (2004; $\alpha = .91$). The scale includes items such as: "I get a real thrill out of driving fast", "I would like to risk my life as a racing driver", "I like to raise my adrenaline levels while driving", and "I sometimes like to frighten myself a little while driving". Higher scores connoted higher driver thrill seeking. (ii) The Competitive Attitude Toward Driving Scale (CATDS) is a five item 4-point Likert-style scale (Donovan, Jessor, & Costa, 1993; $\alpha = .81$) with items: "It's fun to beat other drivers when the light changes", "It's really satisfying to pass other cars on the highway", "It's a thrill to outmaneuver other drivers", "It's fun to weave through slower traffic", and "Taking risks in traffic makes driving more fun". Responses ranged from 1 = strongly disagree to 4 = strongly agree. Higher scores represented a more competitive attitude toward driving. (iii) Risk-Taking Driving Scale (RTDS) is a seven item, 4-point Likert-style scale (1 = never to 4 = very often) (Patil, Shope, Raghunathan, & Bingham, 2006; $\alpha = .83$) querying if while driving you – "take chances for the fun of it; see how fast you can drive out of curiosity; drive dangerously because you enjoy it; test your skills in ways others might find risky." Higher scores reflected higher self-reported risk-taking while driving.

(3) *Driving violations* – A 16-item questionnaire was constructed to assess driving violations (the term "violations" is used to describe risky driving behaviors, not necessarily highway traffic offences). The 11 speeding and other violation questions, excluding seatbelt use, from Tranter and Warn's (2008) version of the Driver Behaviour Questionnaire (DBQ) were used and included questions, such as "exceed the speed limit in populated areas"; "angered by another driver's behavior, you give chase with the intention of giving him/her a piece of your mind". Two questions were slightly modified after pilot-testing to be understandable to Ontarians. The DBQ was initially developed by Reason

et al. (1990) and has been extensively used, revised and psychometrically validated (e.g., Davey, Wishart, Freeman, & Watson, 2007; Reason et al., 1990; Warn et al., 2004). Item content of aggressive violations was increased by inclusion of questions from the 5-item Self Report Driver Aggression Questionnaire (SRDAQ; Hennessy & Wiesenthal, 2001; Hennessy & Wiesenthal, 2005) (e.g., "honk horn at others out of frustration", "swear or yell at others out of frustration"). All items were introduced with the phrase, "How likely would you" and responses were scored on a 6-point Likert type scale (scored 0 = never; 5 = nearly all the time) with higher scores reflecting more involvement in driving violations. A total violations factor including speeding and aggressive violation items were formed by taking the mean of the 13 items in total.

2.2. Sample

Using the Internet, 114 automobile and racing club websites from southern Ontario were identified. The automobile clubs and raceways differed in membership size, type of club (e.g., BMW, vintage vehicles), coverage (i.e., city, province), active administrators and activity level on the website. All websites with an active email were asked to participate through information letters sent to the club's contact person (e.g., webmaster or executive member). The contact person was asked if he/she would be willing to post information about the survey on their website with a link to our online survey. The online survey link included an information letter and the survey. The modified Dillman method was used (Dillman, 2000) whereby clubs were sent weekly reminders for three weeks. The clubs that agreed to participate posted our invitation on their website. Website visitors were invited to fill out the anonymous survey. Respondents who completed the survey were offered a $5 gift card for a national coffee shop chain. The survey took about 20 min to complete. The University of Western Ontario Ethics Board approved the study. The electronic information letters were sent out each week to three websites at a time to monitor response rates. The recruitment period was from June 2, 2010 to January 10, 2011.

A total of 111 clubs and raceways had active emails, although level of activity of these emails was impossible to gauge. Of these, 29 clubs and raceways had at least one completed survey, three refused to participate and the remaining never responded. Response rate of clubs and raceways was 26.13%. It was not possible to determine the response rate of actual respondents to the survey or the representativeness of the sample because it was not possible to determine how many and who visited the website and saw our post, which is a limitation of web-based surveys.

3. Results

The data were collected initially from 503 participants, some of whom did not complete some measures. Other missing cases were handled by listwise deletion method, leaving 395 participants (366 male, 29 female) in the final analysis. Participant ages, measured in categories, were as follows: 97 were between 16 and 24; 94 were between 25 and 34; 42 were between 35 and 44; 82 were between 45 and 54; 57 were between 55 and 64; and 23 were 65 or older. Cross tabulations found that the majority of those who reported owning a hobby vehicle for formal or informal racing (racing enthusiasts) were less than 45 years of age, while the majority of those who reported owning a hobby vehicle for "show and shine" (automobile enthusiasts) were 45 years and older, suggesting that the sample is consistent with demographics of automobile and racing enthusiasts in general (Birch, 2010; Goodyear, 2015; Hamer & Hamer, n.d.; Worldata n.d.). Participants reported driving an average of 13.78 h/week (SD = 10.30 h). The analysis controlled for age, sex, and driving frequency in line with other studies (Parker et al., 1995; Reason et al., 1990). Of the sample, 47.1% reported playing "drive'em up", 57.2% reported playing "circuit", and 45.3% reported playing both racing games. We examined whether those playing *both* games, those playing *only* drive'em up games, and those playing *only* circuit games differed from each other based on their mean scores on critical variables (e.g. age, thrill seeking). It was shown that average scores of thrill seeking, competitive attitudes, and risk taking driving of those playing *only* circuit games were significantly lower and their average age was higher than those playing *both* games or *only* drive'em up games, while there were no differences between these groups on driving violations.

Before the main analyses were conducted, factor structures of the scales were examined with principal axis factoring. The DTSS, CATDS, and RTDS were each a single factor with internal reliabilities of 0.88, 0.83, and 0.81, respectively. Factor analysis of the driving violations revealed two factors of aggressive violations and speeding violations. Items about red light running, unofficial racing, and drunk driving did not load on the factors and were omitted from the analysis (see Yildirim-Yenier, Vingilis, Wiesenthal, Mann, & Seeley, 2015 for an elaboration on the factor structures). A total driving violation factor (DVS) was computed, with an internal reliability score of 0.85. Means and standard deviations of and correlations among the variables are presented in Tables 1 and 2.

Structural equation modelling analyses were performed to examine the relationships among the variables, first in terms of playing "drive'em up" video games and second in terms of playing "circuit" video games. Regarding the former, the measurement model included three latent variables: Playing "drive'em up" video game with a single indicator; risky driver self-concept with three indicators as DTSS, CATDS, and RTDS; and DVS with a single indicator. The fit of the model to the data was assessed by examining relative chi square (chi square/degrees of freedom ratio; χ^2/df), root mean square error of approximation (RMSEA), comparative fit index (CFI) and standardized root mean square residual (SRMR) (Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999). For a model to be good fitting, the relative chi square value should be below 5 or below 2, according to some scholars; RMSEA should be below .06; SRMR below .08; while the CFI should be above .95 (Hooper et al., 2008; Hu & Bentler, 1999). The goodness of fit indices indicated a poor model fit: χ^2/df = 25.38/4; RMSEA = .12; SRMR = .04;

Table 1
Means and standard deviations of and correlations among "drive'em up" video game playing, DTSS, CATDS, RTDS and RDVS variables.

	M/SD	1	2	3	4	5
1. Drive'em up video game	1.91/1.30	–				
2. DTSS	4.31/1.38	0.06	–			
3. CATDS	1.52/0.56	0.10*	0.41***	–		
4. RTDS	1.29/0.41	0.15**	0.39***	0.63***	–	
5. DVS	1.29/0.67	0.02	0.47***	0.47***	0.41***	–

Note. DTSS = driver thrill seeking scale, CATDS = competitive attitude toward driving scale, RTDS = risk taking driving scale and DVS = driving violations scale.
*** $p \leqslant .001$.
** $p \leqslant .01$.
* $p \leqslant .05$.

Table 2
Means and standard deviations of and correlations among the circuit video game playing, DTSS, CATDS, RTDS and RDVS variables.

	M/SD	1	2	3	4	5
1. Circuit video game	2.34/1.61	–				
2. DTSS	4.31/1.38	0.05	–			
3. CATDS	1.52/0.56	−0.04	0.41***	–		
4. RTDS	1.29/0.41	0.01	0.39***	0.63***	–	
5. RDVS	1.29/0.67	−0.03	0.47***	0.47***	0.41***	–

Note. DTSS = driver thrill seeking scale, CATDS = competitive attitude toward driving scale, RTDS = risk taking driving scale and DVS = driving violations scale.
*** $p \leqslant .001$.
** $p \leqslant .01$.
* $p \leqslant .05$.

CFI = .96. Modification indices advised correlating the measurement errors of CATDS and RTDS, which meant that these variables shared some variance not included in the latent variable of risky driver self-concept. The modification improved the model fit; $\chi^2/df = 4.10/3$; RMSEA = .03; SRMR = .02; CFI = 1.00 and the modified model was retained. The structural model was then tested to examine all direct and indirect relationships among the variables. The fit of the overall model to the data was the same as the measurement model. Findings indicated that playing "drive'em up" video games positively predicted risky self-concept ($\beta = .15$, $t = 2.26$, $p \leqslant .05$), which positively predicted driving violations ($\beta = .73$, $t = 8.63$, $p \leqslant .001$) (see Fig. 1).

A second measurement model was tested with "circuit" racing video game playing replacing "drive'em up" racing games in the model to assess the relationships among the three latent variables of playing "circuit" video game (with a single indicator), risky driver self-concept (with three indicators of DTSS, CATDS, and RTDS) and driving violations (with a single DVS indicator). The goodness of fit indices indicated a poor model fit: $\chi^2/df = 27.66/4$; RMSEA = .12; SRMR = .04; CFI = .95. Modification indices again advised correlating the measurement errors of CATDS and RTDS which improved the model fit; $\chi^2/df = 3.96/3$; RMSEA = .03; SRMR = .02; CFI = 1.00. This modified model was retained. The structural model was then tested to examine all direct and indirect relationships among the variables. The fit of the overall model to the data was the same as the measurement model. Findings indicated that playing "circuit" racing video games did not predict risky self-concept ($\beta = .02$, $t = .33$, $p > .05$) or driving violations ($\beta = -.05$, $t = -1.07$, $p > .05$). Only risky self-concept predicted driving violations ($\beta = .72$, $t = 8.67$, $p \leqslant .001$) (see Fig. 2).

We used AIC (Akaike Information Criterion) values to compare the models, as Model 1 (with "drive'em up" racing video game) and Model 2 (with "circuit" racing video game) were non-nested, that is, not a subset of each other. AIC is a fit measure adjusting model chi-square to penalize for lack of parsimony and overparameterization (Garson, 2012). AIC values of models are compared with each other to determine which model is better fitting, with lower values indicating better fit. Findings indicated that the AIC_c[1] value of Model 1 was 1553.91 while the AIC_c value of Model 2 was 1559.05. The AIC_c of Model 1 was lower than the AIC_c of Model 2 and the difference between these values was 5.14, indicating that Model 2 had substantively less support than Model 1 (Burnham & Anderson, 2004).

4. Discussion

The findings of this study are congruent with the experimental studies of Fischer et al. (2009). Their research showed that self-conception as a risky driver was statistically significantly higher among those randomly assigned to play "drive'em up" racing video games than among those assigned to play "circuit" racing video games. Moreover, "drive'em up" video games mediated greater risk-taking behavior on the Vienna Risk-Taking Test-Traffic among participants. The current study, with a

[1] AIC_c = AIC corrected.

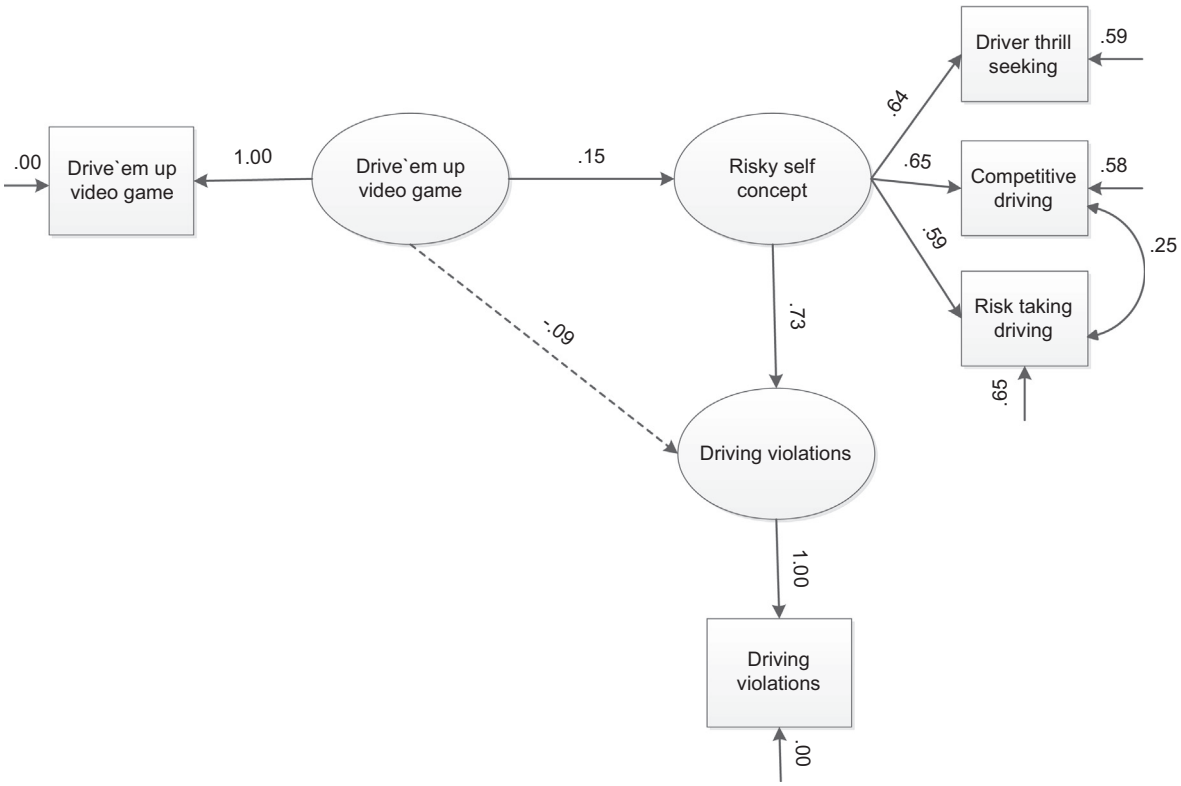

Fig. 1. Structural model for "drive'em up" racing video game playing.

community-based sample, found no direct relationship between "drive'em up" or "circuit" racing video game playing and self-reported driving violations; rather the study found that risky driver self-concept mediated self-reported driving violations for "drive'em up" racing video game playing but not for "circuit" racing video game playing.

In their extended socio-cognitive model of the impact of risky media exposure on risk-taking inclinations, Fischer et al. (2012) suggest that exposure to racing video games, can affect participant's self-concept through different processes related to situational reward cues, active versus passive media consumption and social norms and risk habituation. Their experimental studies manipulated these processes in order to examine the short-term impact on risky driver self-concept, and to determine the path of causality to risk-taking inclinations. However, examination of the longer term relationship between racing video game playing and driving violations cannot easily be measured under laboratory conditions. The current study suggests no direct relationship between racing video game playing and driving violations for "circuit" racing game playing, but an indirect relationship for "drive'em up" video game playing, mediated by risky driver self-concept. As Fischer et al. (2012) write: "Being absorbed in a video car race may help players develop the idea that they themselves are reckless drivers who enjoy breaking traffic laws (via observing behavior of their own character, which is controlled by themselves). This altered perception of self can in turn entail risky behaviour." (p. 243-4).

The results of the current study are also consistent with the findings of the Hull et al. (2012) multi-wave longitudinal study of adolescents investigating the relationship between playing risk-glorifying video games and risky driving. Playing these video games was associated with increased self-reported driving violations (e.g., speeding, tailgating, weaving in and out of traffic), being stopped by the police, crashes and willingness to drive after drinking, which were mediated by sensation seeking and rebelliousness. They write: "The results support a view of video games as affecting real-world behavior by altering a sense of self" (p.244). However, they did not separate the risk-glorifying video game playing by genre in their analyses, so it is not possible to assess whether a particular genre is associated with increased self-reported risky driving.

A number of limitations exist in this study. One key limitation is its correlational nature and thus the study cannot establish causal relationships. It cannot rule out the possibility that self-exposure to racing video games can also be due to risk-taking personality. That is, it is possible that drivers who perceive themselves as risky drivers are more likely to play "drive'em up" video games and also be more likely to be involved in driving violations. Hence, our study cannot establish causality or directionality. However, the research of Fischer et al. used experimental designs which can determine causality and directionality. They found outcomes of increased self-conceptions as a risky driver and increased risk-taking behavior in a video of road traffic scenarios for those participants exposed to the "drive'em up" racing video games, but not the "circuit" racing or non-racing video games. As the participants were randomly assigned to play either the "drive'em up" racing video

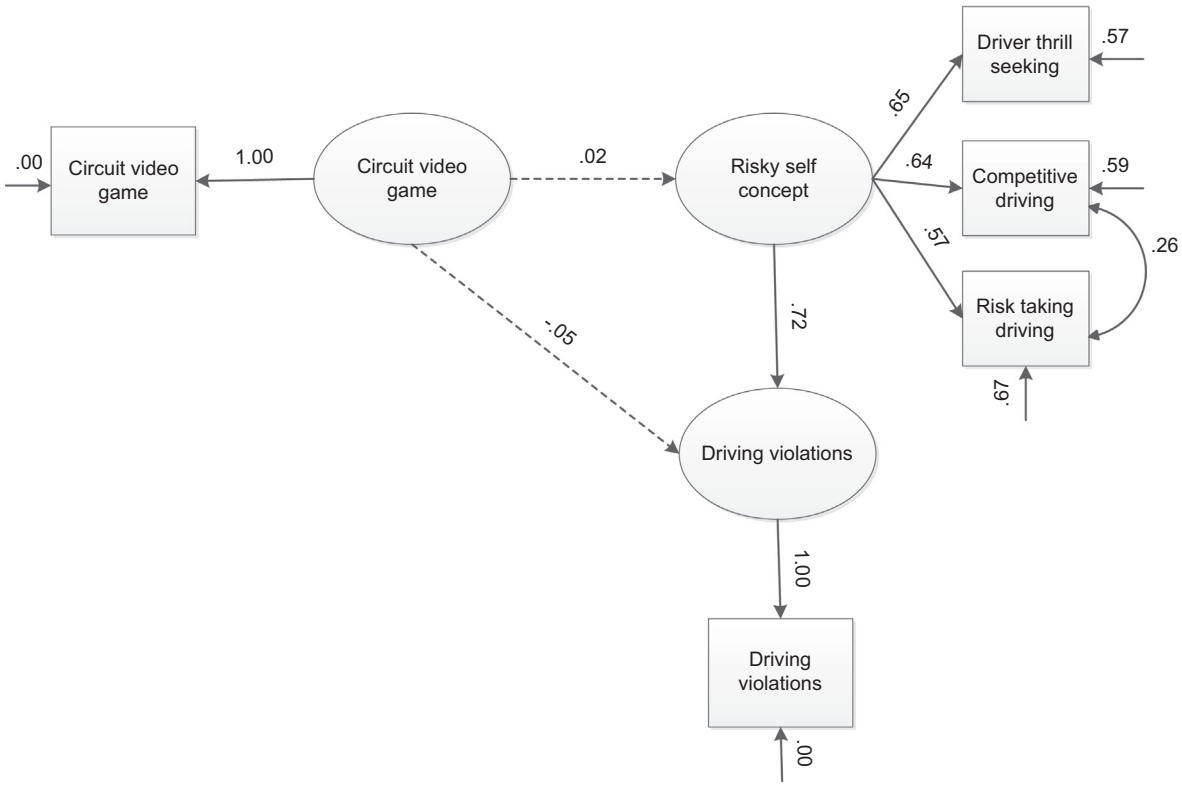

Fig. 2. Structural model for "circuit" racing video game playing.

game or the other games, the subsequent increases in self-conceptions and risk-taking inclinations found only for the "drive'em up" group suggests causality. Yet, the use of experimental and community-based correlational studies can provide useful information for comprehending these causal connections because external validity can be challenged in laboratory experiments which may not represent real world driving (Vingilis & Macdonald, 2002). Additional limitations are the self-report nature of the measures and the large sample of males. Additionally, this sample of automobile and racing enthusiasts may not represent the general population, although it is important to point out that only a small number of this sample reported high risk driving (Vingilis, Seeley, Wiesenthal, Mann et al., 2013). Moreover, it is possible that drivers with risky self-concepts are more likely to admit to their driving violations, while those who do not perceive themselves to be risky are more reluctant to do so. Another limitation is that we did not utilize the full DBQ but rather Tranter and Warn's (2008) version; we used only speeding and aggressive violation items. Other items on drunk driving, red light running and racing did not load on the factors, challenges similarly found by Parker, Lajunen, and Stradling (1998) for drunk driving. These three items showed a very low frequency of endorsement: on the Likert scale of 1–5 the mean score for drunk driving was .26, red light running was .45 and for "getting into unofficial races" was .40, indicating the overwhelming majority of respondents did not report engaging in these activities. The item "getting into unofficial races" correlated with speeding, but did not load, suggesting that perhaps participants did not engage in unofficial racing or the question itself may have been ambiguous, i.e., what is an "unofficial race"? Lastly it is important to note that the correlations between "drive'em up" and "circuit" racing game playing and the other variables was not high, suggesting that the relationships are not strong.

In conclusion, the present results show consistency with the experimental research of Fischer et al. (2009), Fischer, Vingilis et al. (2011) and Fischer, Greitemeyer et al. (2011) and suggest that playing "drive'em up" racing video games rewarding driving violations and risky driving predicts risky driver self-concept, which, in turn predicts self-reported real world driving violations. These relationships fail to hold for playing of "circuit" racing video games. The results of this study, in addition to the experimental work of Fischer et al., can be used to determine future research and traffic safety countermeasures. Further replication is needed with other driver samples to examine whether the patterns and relationships among variables found in this study are generalizable. Additionally, it would be important to determine whether street racing video game playing and risky driver self-conceptions actually affect risk-taking on the roads, although this research could be ethically challenging (Fischer, Vingilis et al., 2011). To sum, street racing video games are very popular among young men, suggesting that further research needs to be conducted on the effects of these games on driving and road safety.

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