22 JULY 2019

IMPULSIVITY, ADOLESCENTS RISK-TAKING & THE ROLE OF RISK EXPOSURE IN TWO SETTINGS

I.N. DEFOE & SVEN ZEBEL

TAMARA PLATENKAMP
UNIVERSITY OF TWENTE

Abstract

The present study investigated the role of alcohol exposure (i.e. risk exposure) in the relationship between adolescents' impulsivity and alcohol use. Namely, we investigated whether the relationship between impulsivity and alcohol use was mediated by alcohol exposure. A second part of the study experimentally manipulated risk exposure, and investigated whether the relationship between impulsivity and risk-taking on the Columbia Card Task (CCT) was moderated by risk exposure. Thus, risk exposure was investigated both as a mediator and moderator. The sample of this study contained 68 adolescents (16-23 years) from four regional education center (ROC) classes, who were per class randomly assigned to a CCT version with either high or low risk exposure. In addition, we used a survey to collect data about adolescents' level of impulsivity, alcohol exposure, and alcohol use. No significant results were found regarding risk exposure as moderator. However, participants with higher alcohol exposure were found to have higher levels of alcohol consumption. Furthermore, results also supported for an indirect-only mediation, indicating that impulsivity predicts adolescent alcohol use via alcohol exposure. For this reason, policy recommendations are suggested regarding alcohol exposure, whereby for example alcohol stores or bars should not be too close located to schools or college.

Impulsivity, Adolescent Real-World and Laboratory Risk-Taking and The Role of Risk Exposure

The increase in risk-taking behaviour during adolescence needs serious attention in order to prevent further harm among this age group. Behaviours such as extreme alcohol consumption with intoxication as a result, nowadays known under the modern shorthand 'binge-drinking', is an example of such an act which should try to be prevented (Gmel, Rehm, & Kuntsche, 2003). From the 791 alcohol-related hospital admissions of underage adolescents in the Netherlands as reported in 2016, at least 550 were registered as alcohol intoxications (de Graaf, 2017). Studies showed that the average age of alcohol intoxication in this same country was at age fifteen in 2017, even though alcohol consumption is not even legalised at that age yet (de Graaf, 2018). This is really worrisome, especially since research revealed that alcohol consumption among adolescents affects the physical- and/or mental well-being, and further predicts delinquent behaviour in later adulthood (Richardson, Freedlander, Katz, Dai, & Chen, 2014). In addition, academic achievement might be impaired since alcohol use showed to have links with lower college grades (University of Minnesota, 2008). However, it is shown that especially among college students more alcohol is consumed due to environmental factors (Wechsler, Kuo, Lee, & Dowdall, 2000). To better illustrate, binge drinking among students is found to be associated with the location of a bar within a mile of campus (Wechsler et al., 2000).

As becomes clear, multiple factors can have an influence on behaviour. Examples of factors which could influence behaviour can thereby be internal (e.g. personality, attitudes etc.) or external (e.g. exposure to alcohol etc.). Therefore, the current paper examines the role of both an internal factor, namely the personality trait impulsivity, and an external factor, namely risk exposure, while predicting adolescent risk-taking behaviour as alcohol use. Hereby, impulsivity is defined as the tendency to act without much deliberation or consideration of consequences (Zuckerman & Kuhlman, 2000). An example of risk exposure related to alcohol can be the presence of pubs or alcohol stores, or any other physical exposure to alcohol. In the first research question, alcohol exposure serves as a mediator, namely: *Does impulsivity predict adolescent alcohol use via alcohol exposure?*.

However, the meta-analysis of Defoe, Dubas, Figner, and Van Aken (2015) focused on age differences in risky decision making and suggested a hybrid theory wherein 'risk opportunity' or 'risk exposure' is seen as crucial variable to explain prior found inconsistencies in results between real-world risk-taking and laboratory measure of risk-taking among children and adolescents. Hereby, they suggest that equally found laboratory risk-taking levels of children and adolescents reflect real-word risk-taking levels, but suggest that adolescents engage in more real-world risk-taking because they have more opportunity and/or exposure to risk than children (Defoe et al., 2015). Based on this, the current paper also investigates laboratory risk-taking among adolescents, however, use will be made of a risky choice task, since for ethical reasons we do not expose (underage) adolescents to alcohol in laboratory. In the second research question, risk exposure serves as a moderator, namely: *Is the relationship between impulsivity on laboratory risk-taking moderated by risk exposure?*.

In sum, the current paper investigates both internal (i.e. impulsivity) and external (i.e. risk exposure) factors while predicting adolescent risk-taking in both real-world (i.e. alcohol use) and laboratory settings (i.e. risky decision-making task). In this manner, both results will be compared in order to investigate whether it can be stated that more risk exposure (i.e. alcohol exposure) leads to more risk-taking (i.e. alcohol consumption) and might account for prior mentioned inconsistencies of risk-taking results.

The role of impulsivity

The personality trait impulsivity is shown to be one of the strongest predictors of substance use, especially under students (Bailey, 2011). In order to make rational choices instead of acting impulsive, we rely on our cognitive control and its executive functions (Mozer, 2006). However, the cognitive control just starts to stabilize by adolescence, whereby other subcortical brain regions develop faster (Somerville & Casey, 2010; Steinberg, 2010). Based on this, Neurodevelopmental imbalance models suggest that the less mature cognitive control system of adolescents may be challenged by more mature socioemotional brain systems which override the cognitive control (Somerville & Casey, 2010; Steinberg, 2010). This may cause adolescents to act rather impulsive than based on rational reasoning, wherefore those who already had higher levels of impulsivity might be more vulnerable to this.

Research showed that men who scored higher on impulsivity used more alcohol in comparison with those who scored lower on this trait (Waldeck & Miller, 1997). Based on this and some other assumptions, the prospective study of Granö, Virtanen, Vahtera, Elovainio, and Kivimäki (2004) examined the relationship between impulsivity and alcohol use for both genders, and made use of two questionnaires with a two-year interval to measure levels of this trait and alcohol consumption. They found longitudinal associations between self-reported alcohol use and impulsivity, whereby levels of impulsivity predicted an increase in drinking as shown by the two-year follow-up for both genders. In addition, it was found that individuals with higher levels of impulsivity had a greater likelihood to become heavy drinkers (Granö et al., 2004). Finally, a study focused on risk factors for nicotine and other drug abuse among adolescents made use of a delay-discounting task, whereby they found heavy drinkers to be more impulsive than light drinkers (Carroll, Anker, & Perry, 2009). As far impulsivity and laboratory risk-taking, self-reported levels of impulsivity were found to correlate with a measure such as the The Balloon Analogue Risk Task (Lejuez et al., 2002). Additionally, the study of Penolazzi, Gremigni, and Russo (2012) also found that individuals who scored higher on impulsivity engaged in more risk on the CCT than low impulsive individuals.

The role of risk exposure

The role of alcohol exposure on alcohol consumption among adolescents is supported by the study of Maimon and Browning (2012), who investigated the effects of residential environments on drinking. Namely, they evidenced that adolescents' alcohol use increases when alcohol was sold in the close neighbourhood. Thereby, also the effect of alcohol exposure as part of many students environment on adolescent alcohol use is supported by the study of Wechsler et al. (2002), who found that college students binge drink more than their former high-school classmates who did not go to college.

The meta-analysis of Defoe et al. (2015) expect that also higher risk exposure in laboratory settings leads to higher levels of risk-taking. Prior research focused on over-eating already investigated whether variety of environment in laboratory settings changes the effect of impulsivity on measure of food-intake among children. Results showed a significant interaction between impulsivity and environmental variety to this laboratory measure (Guerrieri, Nederkoorn, & Jansen, 2007).

Exposure as a mediator

In the study of Kahler et al. (2003), it was examined whether individual characteristics have an influence on alcohol consumption, either directly or indirectly, by affecting the selected environment. They suggest with the support of an interactive framework, that the association of adolescent's environment and alcohol consumption is reciprocal, indicating that alcohol consumption is affected by the environment, but that the selected environment is affected by individual characteristics (Kahler et al., 2003). The effect of the environmental variable alcohol accessibility, is already supported among youths with disinhibited personality traits (e.g. impulsivity) to facilitate drinking (Pedersen & McCarthy, 2008). In addition, Wechsler et al. (2000) focused in their study on person-environment transactions and found support for an additive model in which both personality and the environment make unique contributions to youth drinking behaviour over time. Therefore, they suggest that youths with disinhibited personality traits (e.g. impulsivity) drink more alcohol since they have a greater likelihood to select environments in which alcohol is easier accessed (Wechsler et al., 2000). The study of Kahler et al. (2003) examined this suggested relationship while focusing on the personality trait sensation-seeking and found support that sensation-seeking predicts alcohol use, in part, via selected environments which encourage drinking.

However, unlike these studies, the current study investigates alcohol exposure among adolescents as environmental variable. Hereby, it is expected that more impulsive adolescents are more exposed to alcohol, which in turn leads to more alcohol consumption, indicating alcohol exposure as mediator.

Exposure as a moderator

Defoe et al. (2015) suggest that also higher risk exposure in laboratory measure will lead to higher levels of risk-taking. Therefore, since high impulsive adolescents in real-world might consume more alcohol due to their higher environmental alcohol exposure, it will also be examined whether high impulsive adolescents take more risk when they have higher risk exposure on laboratory measure (CCT). The role of variety in exposure on laboratory measure is already examined, whereby results supported variety in food exposure to moderate the effect of impulsivity on laboratory measure of food-intake among children (Guerrieri, Nederkoorn, & Jansen, 2007). Therefore, it was evidenced that whenever high impulsive children were exposed to a variety of

food, they consumed more food than low impulsive children with the same exposure (Guerrieri, Nederkoorn, & Jansen, 2007). In other words, results showed a significant interaction between impulsivity and environmental variety to this laboratory measure (Guerrieri, Nederkoorn, & Jansen, 2007).

However, since an experiment as Guerrieri et al. (2007) did with food is not ethical to do with alcohol and (underage) adolescents, the current study will examine whether impulsivity interacts with the manipulated variable risk exposure to predict risk-taking on a laboratory measure, the Columbia Card Task (CCT: Figner, Mackinly, Wilkening & Weber, 2009). Hereby, it is expected that whenever high impulsive adolescents are exposed to more risk on laboratory measure, they take more risk than adolescents with low impulsivity with the same exposure.

The current study

In sum, the current paper examines predictors of risk-taking behaviour among adolescents and focuses hereby on impulsivity and risk exposure (e.g. alcohol exposure). While doing so, both real-world adolescent alcohol consumption and laboratory risk-taking as measured on the CCT will be used. Therefore, this paper will first examine whether impulsivity predicts alcohol use among adolescents (1a). Next, we will answer the question whether impulsivity predicts alcohol exposure in the real-world (1b). In addition, we will examine whether exposure to alcohol predicts alcohol use in adolescents (1c). The combination of these three individual sub-questions together, should give an answer to the first main mediational question of this paper: (*1.) Does impulsivity predict adolescent alcohol use via alcohol exposure?*. It is hypothesised that impulsivity has some relationship to alcohol use among adolescents, since this personality trait is already supported by research to be a strong predictor of this consumption (Bailey, 2011). However, this relationship might be (partly) explained by the variable alcohol exposure, since youth with high levels of disinhibited personality traits (e.g. impulsivity) are suggested to drink more due to their selected environments with easy alcohol access (Pedersen & McCarthy, 2008). Thereby, selected social environments among students are already evidenced to partly mediate the relationship of the close to impulsivity related personality trait sensation-seeking and alcohol use (Kahler et al., 2003). For this reason, a partial mediation is hypothesised, whereby some effect of impulsivity on adolescents alcohol use can be explained via alcohol exposure.

However, this study will also focus on a laboratory measure of risk-taking. Therefore, the variable risk exposure will be manipulated on the CCT, resulting in two conditions with different levels of risk exposure (high vs. low). Due to this, it can be examined whether impulsivity interacts with the CCT condition in order to answer the second research question of this paper: *(2.) Is the effect of impulsivity on CCT risk-taking moderated by risk exposure?.* It is expected that the role of impulsivity on CCT risk-taking depends on the CCT condition, indicating an interaction effect. To better illustrate, it is hypothesised that adolescents with high levels of impulsivity take more risk in the high-risk exposure condition of the CCT than in the low-risk exposure condition, since high impulsive adolescents also drink more alcohol when they are more exposed to it in the real-world. However, adolescent with low levels of impulsivity are expected to have equal levels of risk-taking between both conditions.

To conclude, based on these expected relationships, it is hypothesized that more risk exposure (i.e. alcohol exposure) leads to more risk-taking (i.e. alcohol consumption) and may account for inconsistencies between real-world evidence and laboratory risk-taking measure among children and adolescents. Figure 1 below displays an illustration of the hypothesised models.

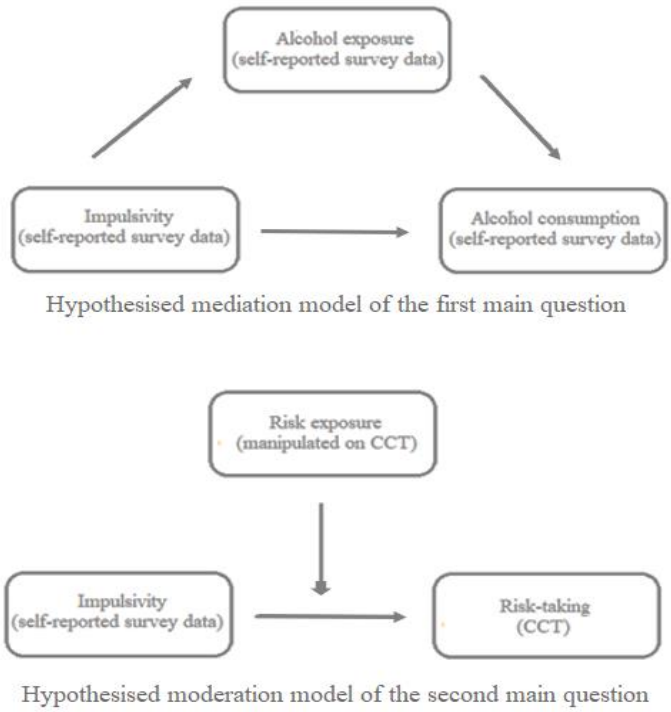

Figure 1. Hypothesised models regarding the two research questions

Method

Sample

The participants were 68 adolescents between 16-23 years old (*M* age = 17.79; *SD* age = 1.51; 35.3% male; 64.7% female) from four different classrooms in secondary vocational education (ROC). The students were either 1st (*n*= 28) or 2nd (*n*= 40) grade and studied at the highest level of this education (four). The schools were located in either Almelo or Enschede, which is in the Twente region of the Netherlands. Most of the participants had the Dutch nationality (94.1%), whereby all of them were still living at their parents or caregivers. The majority of the participants was not religious (55.9%) while 29.4% was Christian, 4.4% Islamic, and 7.8% of another religion. All students were informed about the nature of the study by a passive informed consent for inclusion.

Measures

Impulsivity was measured with five items from a shortened version of the original Eysenck Impulsiveness Scale (Eysenck, & Eysenck, 1978), which was validated and had the high factor loadings (Vitaro, Arseneault, & Tremblay, 1997). An example of a question is: 'Do you often get in trouble because you do things without thinking?. However, the questionnaire was translated into Dutch. The five items were answered with the following response format: 0 = Completely disagree; 1 = Disagree; 2 = Not disagree, not agree; 3 = Agree; 4 = Completely agree. The items had an Cronbach's alpha for internal consistency of .45. However, by analyzing inter-item correlations it was found that whenever one item would be excluded (item 4: I always think before I act), the Cronbach's alpha would raise to .80. The mean inter-item correlation of all five items was just .09, the ideal range is .15 to .50, whereby without item 4 the inter-item correlation would be .50 (Trochim, 2006).[1]

Alcohol use was measured with the following two items which were translated in Dutch: (1) 'Did you ever drink alcohol?', (2) 'Did you get tipsy or drunk as result from drinking alcohol?'. The following response format was used: 0 = Never; 1 = Not in the past 12 months; 2 = Yes, but

[1] No (new) significant effects were found when the item which would raise the Cronbach's alpha was deleted during analysis.

less than once a month; 3 = Yes, at least once a month; 4 = Yes, at least once a weak; 5 = Yes, every day. The items had an Cronbach's alpha for internal consistency of .86.

Alcohol exposure was measured with three items. An example of a question is: 'Is there in your direct living environment often alcohol available?'. However, the answer categories for one item were inconsistent with those of the other two items. Two items were answered with the following response format: 0= Never; 2= Rarely; 3= Once in a while; 4=Often; 5=Very often; 6= Always. One item was answered with the following response format: 0= Never; 2= Rarely; 3= Once in a while; 4=Often; 5=Very often; 6= Always. Hereby, the three items had a negative mean inter-item correlation, however, whenever one item would be excluded (item 5: I can easily access alcohol), the Cronbach's alpha would be .77. [2]

Laboratory Risk-taking was assessed in Opensesame (Mathôt Schreij, & Theeuwes, 2012) by means of the Columbia Card Task (CCT), whereby use was made of the ´hot version´ as developed by Figner, Mackinly, Wilkening and Weber (2009). The overall goal of the task was to accumulate as many points as possible during 24 trials of this decision-making task. The total amount of points achieved at the end was framed in cents from which a raffle took place among all participants. Participants could gain or lose points per round by flipping cards, hereby, the total displayed number of cards was 32. However, there were two types of cards, namely a win card or a loss card. The value of a win card was either +10 or +30 points, whereby the value of a loss card was either -250 or -750 points. Per round, it was displayed how many loss card there were, this was either one or three, and what the value of the win- and loss cards was. After flipping a card, feedback was immediately given by showing a green happy smiley for a win card and a red sad smiley for a loss card. Participants had 30 second per round as displayed by a timer on the screen, however, whenever a loss card was flipped over, the round immediately came to an end. Additionally, there were two different conditions of the CCT, namely a ´with no-card´ option and a ´without no-card´ option. In this manner, risk exposure was manipulated on the CCT. Hereby, the ´with no-card´ option was considered to be less risky since participants could decide not to flip a single card around.

[2] [2] No (new) significant effects were found when the item which would raise the Cronbach's alpha was deleted during analysis.

Alcohol use was measured with the following two items which were translated in Dutch: (1) 'Did you ever drink alcohol?', (2) 'Did you get tipsy or drunk as result from drinking alcohol?'. The following response format was used: 0 = Never; 1 = Not in the past 12 months; 2 = Yes, but less than once a month; 3 = Yes, at least once a month; 4 = Yes, at least once a weak; 5 = Yes, every day. The items had an Cronbach's alpha for internal consistency of .86.

Procedure

Before the research could be conducted, approval was necessary by the Ethics Committee of the Faculty of Behavioural Sciences of the University of Twente. After approval, schools were approached via emails about the purpose and topic of the study which gave them the opportunity to either agree or refuse to participate. If the schools did not answer to the email within two to four working days after the email was sent, the research assistants then contacted the schools by telephone. Nonetheless, if schools decided to participate, the actual participants themselves received a passive informed consent form in which they had the right to refuse participation. Participants thereby had the opportunity to choose between a €5 voucher which they would receive immediately, or to participate in a raffle after the entire data collection from which the price was a €150 voucher. However, an additional small raffle took place at the end of every CCT session whereby the price of a €10 voucher was randomly assigned to a participant.

The researchers visited the schools to conduct the research, which took place in a classroom or a computer room and approximately took an hour. Before the start, one of the researchers discussed some general information and explained how the research would be conducted. Hereby, everyone got informed about their participation in the survey and the card game ('Columbia Card Task'). The design which was executed was a between-subjects design whereby participants were randomly assigned per class to either the high or low risk exposure condition of the CCT. The participants received the survey either via the computer/laptop on OpenSesame or could fill in a paper-pencil version whenever there were technical constraints. On a blackboard or screen, difficult words were explained. After the questionnaire, the CCT was played. However, before the start was demonstrated on a screen how to perform this task.

Statistical approach

Data was analysed by making use of the IBM Statistical Package for the Social Sciences (SPSS) version 25 (IBM, n.d.). Descriptive statistics were used for demographics as age, gender, etc., wherefore they were used as well for the average level of risk-taking (CCT), CTT condition, impulsivity, and alcohol consumption.

First of all, to examine whether impulsivity predicts alcohol use (in part) because of alcohol exposure, a mediation analysis was conducted using the *PROCESS* tool (Hayes, 2017). Three regressions were conducted in order to assess for mediation. The first regression had impulsivity predicting alcohol use, the second had impulsivity prediction alcohol exposure, and the last had impulsivity and alcohol exposure predicting alcohol consumption. Whenever the direct relationship between impulsivity and alcohol use becomes insignificant, while the indirect effect with alcohol exposure as mediator turns out to be significant, a full mediation takes place. However, a partial mediation takes place whenever the relationships between impulsivity and alcohol exposure becomes weaker, but is still different from zero whenever alcohol exposure is introduced.

Second, a moderation analysis was conducted in order to examine whether risk exposure on the CCT interacts with impulsivity on laboratory risk-taking measure. Hereby, a median split was done in order to turn the continuous independent variable impulsivity in a categorical one with the conditions of low- and high impulsivity. For this reason, it was allowed to test for a possible interaction effect with factorial Analysis of Variance (ANOVA) (Allen, 2017). Hereby, moderation is evidenced whenever the interaction *impulsivity x CCT condition* on CCT risk-taking is significant.

Results

Descriptive statistics

Table 1 provides the descriptive statistics for the study variables. However, the normality of the data will first be discussed by interpreting the skewness of the distribution according to the rule of thumb as suggested by Bulmer (1979). Namely, the distribution is skewed with a value below -1 or above +1, whereby the data is considered to be relatively symmetric with a value

below -.5 or above +.5. For the interpretation of the kurtosis of the sample, no clear rule of thumb is available (Brown et al., 2015). Nonetheless, the kurtosis can be close to 0 which indicates a normal distribution, whereby higher than 0 indicates a high peak in the distributions, and smaller than 0 indicates a distribution which if flattened.

The distribution of mean scores on the CCT was skewed with a value of -.19 (SD = .29) and a relatively small peak with kurtosis of .46 (SD = .57). The mean scores of the total alcohol use was slightly flattened and had a skewness of -.68 (SD = .29) and kurtosis of -.71 (SD = .57). The distribution of total alcohol exposure was moderately skewed with -.41 (SD = .30) which indicated relative symmetry, with a kurtosis of 1.36 (SD = .58). Impulsivity as last, was also moderately skewed with .51 (SD = .30) and had a kurtosis of .58 (SD = .58).

Table 1

Correlations of studied variables

Measure	1	2	3	4	5	6	7	*N*	*M*	*SD*
1. Impulsivity	-							68	1.98	.32
2. Alcohol use	.16	-						68	2.53	1.40
3. Alcohol exposure	.24*	.52*	-					68	2.10	.77
4. Age	.19	.10	.074	-				68	17.79	1.51
5. CCT-average	.17	-.01	-.16	-.12	-			68	8.83	2.20
6. CCT low RE	.07							28		
7. CCT high RE	.20							40		

** $p < 0.05$*

RE = risk exposure

The correlations between measured variables are next to the means per variable illustrated in Table 1. Hereby, impulsivity was positively related with alcohol exposure, meaning that higher levels of impulsivity related to high levels of alcohol exposure. In addition, a significant correlation is shown according to Pearson's correlation, whereby alcohol exposure was positively related with alcohol use. This means, that a higher level of alcohol exposure is related to a higher alcohol consumption.

Mediation analyses

Using the *PROCESS* tool, risk exposure was tested as a mediator between impulsivity and alcohol consumption. Hereby, it was shown that the total effect of impulsivity on alcohol use is not significant: B = .68, SE = .54, Bca CI [-.40, 1.75]. As shown in Figure 2 below, regarding impulsivity and alcohol exposure, the results approached significance (path a): B = .58, SE = .30, Bca CI [-.01, 1.18]. Thereby, the relationship between alcohol exposure and alcohol use (path b) was significant: B = .90, SE = .20, Bca CI [.49, 1.29]. Focusing on the direct and indirect effect (path c), no significant direct effect of impulsivity on alcohol use was found: B = .15 SE = .48, Bca CI [-.81, 1.12]. However, a significant indirect effect of impulsivity on alcohol use through alcohol exposure was found B = .52 SE = .26, Bca CI [.03, 1.06].

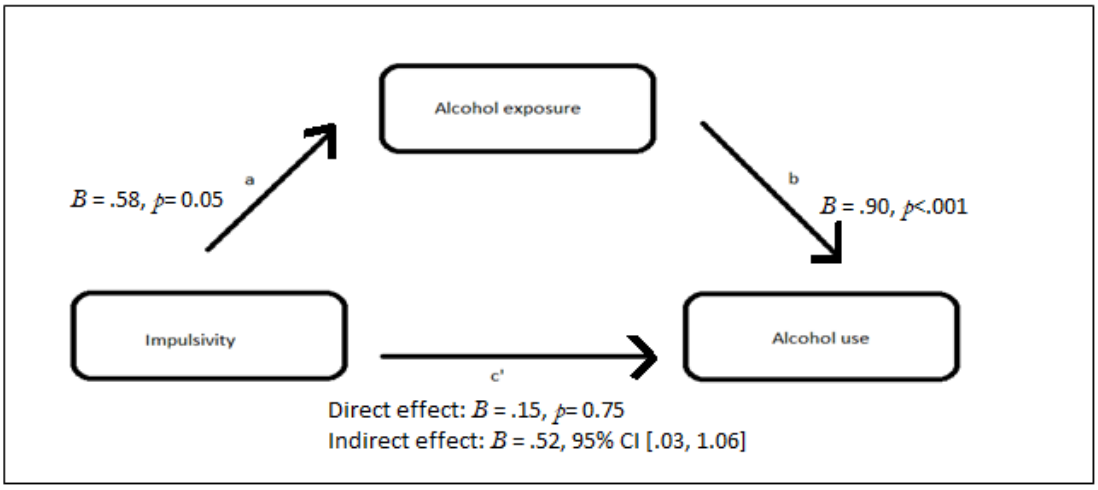

Figure 2. Mediation model with alcohol exposure as mediator and impulsivity as predictor.

Moderation analyses

A factorial ANOVA was executed in order to test whether the relationship between impulsivity and CCT risk-taking is moderated by risk exposure as manipulated on the CCT. Hereby, the continuous variable impulsivity was categorised into the condition high vs. low impulsivity by executing a median split. The sample had a median of 2.0, resulting in an unequal distribution among the two conditions of impulsivity (high n=28 vs. low n=40). The relevant results of the ANOVA regarding the suggested relationship and the effect of risk exposure are presented below in Figure 3.

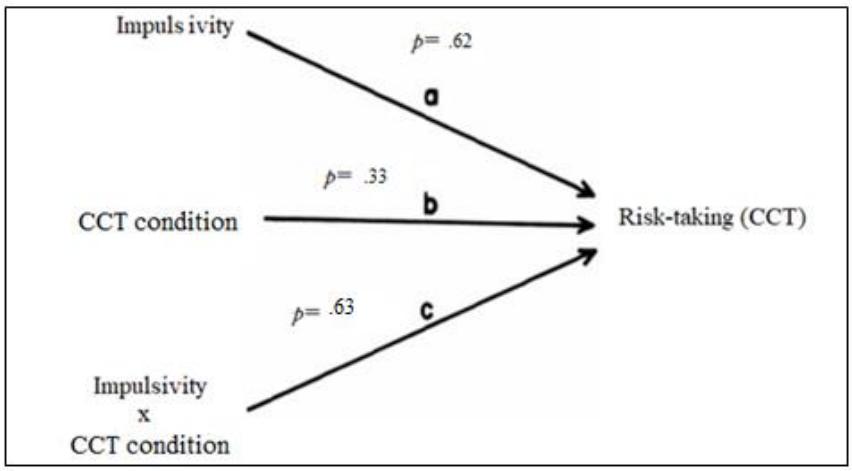

Figure 3. Moderation model with CCT condition as moderator.

There was no significant main effect found for the relationship between impulsivity and CCT risk-taking (path a): $F(1,24) = .23$, $p= .62$. Thereby, neither was a significant main effect found for risk exposure as manipulated on the CCT and risk-taking (path b): $F(4,94)= .97$, $p= 0.33$. Lastly, there was no evidence found to support the interaction term of impulsivity x risk exposure on CCT risk-taking (path c): $F(1,23) = 0.24$, $p= .63$, indicating that the null hypothesis was not rejected.

Discussion

This paper investigated predictors of risk-taking behaviour among adolescents, and focused on the role of both impulsivity and risk exposure. Specifically, we investigated whether

impulsivity predicts alcohol use among adolescents via alcohol exposure. However, since the variable risk exposure (e.g. alcohol exposure) is suggested by Defoe et al. (2015) to fill the gap of inconsistent risk-taking results between children and adolescents, it was also investigated whether risk exposure changes the role of impulsivity on laboratory measure of risk-taking. For this reason, focus was on both real-world evidence of adolescent risk-taking, namely adolescent alcohol consumption, and laboratory measure of risk-taking, namely the CCT decision-making task. It was hypothesised that impulsivity has some relationship to alcohol use, however, whenever alcohol exposure is introduced this path was expected to reduced but stay different from zero. In other words we hypothesized a partial mediation effect. It was further hypothesised that the effect of levels of impulsivity on CCT risk-taking changes depending on the level of risk exposure, suggesting a significant interaction between levels of impulsivity and CCT condition. In short, neither of these hypothesises was fully supported by results of this study, however, evidence to support an indirect-only mediation was found.

Exposure as mediator

Three individual sub-questions constituted in order to answer the first main research question of this paper. First of all, the results of this study regarding the direct link between impulsivity and alcohol use only approached significance. This result is not in line with expectations based on prior research. Namely, the study of Granö et al. (2014) found impulsivity to be a predictor of alcohol consumption. However, they used questionnaires with two-year intervals and found impulsivity to be predictive over time, in a sample of adults (Granö et al., 2014). Therefore, these differences in the sample and procedure of the current study could have an effect on the results, and may explain why no support was found for the hypothesised relationship in this study. In addition, also support for heavy adolescents drinkers to be more impulsive came from a study which used a delay-discounting task instead of survey to measure levels of impulsivity, and may due to this different measure have found different results (Carroll, Anker, & Perry, 2009).

Second, no significant relationship was found for impulsivity to alcohol exposure. This is against the suggestion of Wechsler et al. (2000) who expected youths with disinhibited personality traits (e.g. impulsivity) to drink more alcohol due to their environmental selection which makes alcohol easier accessible. However, even though it might be the case that more impulsive

individuals select more environments with easier access to alcohol (e.g. student associations), this will not mean in first stance that their physical exposure to alcohol has to be increased. To better illustrate, the current study focused on the presence of alcohol in the environment, nonetheless, environments as the campus do not per se expose physical alcohol cues, but might make access to alcohol at for example study associations easier which increases the opportunity to consume it.

Third, a significant relationship was found between mediator alcohol exposure and dependent variable alcohol use, indicating that more alcohol exposure leads to more alcohol use. This is in line with evidence found in the study of Maimon and Browning (2012), whereby they supported that adolescents alcohol use increased when alcohol was sold in the close neighbourhood. Also, the study of Wechsler et al. (2002) found that more alcohol was consumed among those of their sample who went to college after high-school in comparison to those classmates who did not continued studying. Hereby, they suggest that college students consume more alcohol since it is part of many students environment and therefore promoted (Wechsler et al., 2002).

Regarding the first sub-question, famous applications of mediation analysis as Baron and Kenny (1986) do usually not consider mediation without significant direct effect (MacKinnon, Krull, & Lockwood, 2000). However, a significant indirect effect was found, which supports for a relationship between impulsivity and alcohol use among adolescents via alcohol exposure. McFatter (1979) considered the possibility of mediation without significant direct effect, and presented a plausible hypothetical situation in which such inconsistent mediation could occur. Hereby, some effects cancel each other out and may therefore not support for a significant direct and total effect, but significant indirect effect only (MacKinnon et al., 2000). To better illustrate, based on this example it could be hypothesized that high impulsive adolescents do not consume more alcohol, but are more exposed to alcohol in their environment, and alcohol exposure is positively associated with alcohol use and serves as mediator in this relationship. From a more theoretical perspective, we conclude that the results support for an indirect-only mediation (Zhao, Lynch, & Chen., 2010). This type of mediation is based on different assumptions as the Baron and Kenny (1986) analysis and overlaps with their definition of full mediation, but lacks a direct effect (Zhao, Lynch, & Chen., 2010).

Exposure as moderator

Results of this study could not support the relationship of impulsivity and CCT risk-taking. This result is against expectations based on prior research, since high impulsive adults were found to engage in more CCT risk-taking than those with lower levels of impulsivity (Penolazzi, Gremigni, & Russo, 2012). Nonetheless, the inconsistency of results may be due to sample differences, since this paper focused on adolescents instead of adults, whereby differences among the used CCT should also be taken into consideration. Namely, in the study of Penolazzi et al. (2012), they examined the relationship of impulsivity and CCT risk-taking by making use of both CCT conditions, in order to dissociate in processes of decision-making (i.e. 'hot, emotional'; 'cold, deliberative'). Thereby, support for higher risk-taking levels among higher impulsive individuals was only found for the cold CCT version (Penolazzi, Gremigni, & Russo, 2012). However, for this paper we used the hot version of the CCT, manipulated the risk exposure variable which resulted in two conditions of this task, and added a timer of 30 sec. per trial, which could all have had an effect on the results.

In addition, the effect of impulsivity on CCT risk-taking was not found to be moderated by risk exposure, indicating no support for the interaction effect *impulsivity x CCT condition = CCT risk-taking*. For this reason, also no evidence was found for the suggestion in the meta-analysis of Defoe et al. (2015) that higher risk exposure leads to higher risk-taking in a laboratory measure. This is against expectations based on the study of Guerrieri et al. (2007) which focused on food intake and variety in the food environment among children. Namely, they found that whenever the food environment was manipulated on variety in laboratory measure, children with higher levels of impulsivity consumed more food in comparison to those with lower levels of impulsivity (Guerrieri et al., 2007). However, the paper of Guerrieri et al. (2007) made use of laboratory measure for impulsivity instead of self-reports, whereby they focused on the constructs reward sensitivity and response inhibition. This could have an effect on the results, and may therefore explain why no support was found for the hypothesis of this study. Also, the version of the CCT with its manipulated variable risk exposure used in this paper was never tested before. For this reason, the effect of the manipulation to be sufficient in resembling two different condition with difference in perceived risk exposure was not yet evidenced and may have influenced results.

Strengths and limitations

What makes this paper strong, is that next to the fact that focus is on both an internal- and external factor which could influence risk-taking behaviour among adolescents, the actual risk-taking data itself is collected by making use of both self-reports and laboratory measure. Usually, studies use one of these methods to collect data, however, both have their own strengths and limitations (Stangor & Walinga, 2014). Therefore, making use of both types of methods might give new interesting insights, especially since the variable risk exposure might fill the gap between inconsistent results of real-world evidence and laboratory measure of risk-taking between children and adolescents (Defoe et al., 2017). However, some limitation of this study might have influenced the results and will therefore be discussed. These issues are related to the used measurements, the procedure and data collections, and the sample of this study.

Measurement issues

First of all, impulsivity overlaps with subcomponents of the executive function due to its several distinct facets and is suggested to be a multidimensional trait since its several underlying distinct aspects can be measured (Fernie et al., 2013). Therefore, instead of focusing on self-reported measure of impulsivity, dimensions as response rapid-resonse and reward-delay could have more predictive power to risk-taking as already supported by laboratory measure which are also suggested to be more reliable than self-reports (Jauregi, Kessler, & Hassel, 2018). However, since survey data is easier to collect and prior research related to this study found significant effects with self-reported impulsivity, this measure was still used but could have influenced the results since the multidimensionality of this trait is not taken into consideration.

Second, issues were found regarding the content of the survey. Namely, the answer categories for one item of alcohol exposure were inconsistent with those of the other two items and may account for the low internal consistency of this scale. However, since the interpretation of the item categories between the two formats was closely related, they were still suggested to indicate the same levels of exposure and the item was not removed but might be a confound due to its low reliability, since now we do not know whether the items measure the same underlying construct.

In addition, also an error was found in the introduction text of the two conditions of the CCT. Namely, both conditions had the instructions which were applicable for the low risk

exposure condition only. Due to this oversight, it might be that participants in the high risk exposure condition did not fully understand the 'no-card' function which could have influenced the effect of this manipulated variable.

Procedure and data collection issues.

The presence and/or behaviour of the teacher during the data collections can be considered as a confounding variable. To better illustrate, sometimes the teacher was just waiting at the his/her desk till the session was over, whereby at other times the teachers were more involved and were for example walking around and/or answered questions about difficult words of the survey. For this reason, participants might have felt unpleasant with the close presence of the teacher and did therefore not respond .

Finally, all the participants of the research started with first the survey, and hereafter they conducted the CCT on the computer. However, due to this unchanging procedure, there could not be controlled for order effects which might have an influence on the results (Eugene, Zechmeister, Shaughnessy, & Zechmeister, 2014). To better illustrate, it could for example be that participants their behaviour on the CCT was influenced by the survey since they felt fatigue after concentrating on this task which influenced their CCT results.

Sample issues

First of all, the sample can be considered as relatively small (n=68), but has a wide age range (16-23 years), wherefore controlling for age might have been necessary. Namely, alcohol exposure may suggested to be positively influenced by age, since age depending factors as college environments often encourage drinking, whereby the minimum age law for alcohol in the Netherlands is eighteen (de Graaf, 2018; Kahler et al., 2003). However, results did not support this assumption as shown in Appendix 1. Second, data was collected among adolescents living in the Twente region only which could have influenced the results since statistics show that alcohol is not consumed in equally amounts among the regions of the Netherlands (GGD Nederland, 2018). Thereby, the Twente region falls under the category that consumes the least amount of alcohol. For this reason, the sample can considered to be representative for Twente only, and no conclusions can be drawn regarding the whole population of the Netherlands. In addition, considering that the

Twente region was used could account for the low ethnic diversity of this sample as well (CBS, 2016), which does not reflect the ethnically-diverse population of the Netherlands.

Future directions

Considering that social media use is increasing and especially among the age group of adolescents, it is highly recommended for future research to take risk exposure on social media platforms into consideration as predictor of risk-taking. Exposure to excessive drinking games on social media for example, is such a factor which could influence adolescents own drinking behaviour. The 'neknominate' hereby, is an online drinking contest whereby use is made of social media (Barbieri et al., 2018). The rules of the game require that a participant uploads footage of themselves drinking an alcoholic beverage in one time (Barbieri et al., 2018). Together with their uploaded material, they nominate in their uploaded post other friends to do the same as them. The exposure to this kind of content on social media however, can promote certain risk-taking behaviour among adolescents. Studies hereby already evidenced how problematic this issue is, and stated that the increase of alcohol intoxications as consequences of drinking games as the Neknominate is alarming and forms a serious problem for the public health (Barbieri et al., 2018). However, whenever this research would be conducted, the influence of peers is also suggested to be taken into consideration, since the participants nominate other people in their post which is open for a wide public.

In addition, since no significant effects were found for the CCT in this study, future similar research is suggested to also focus on an adjusted manipulation of risk exposure on this task. Namely, it could for example be considered whether the high risk exposure condition should contain more loss cards, and/or the value of these loss cards should be higher, in order to replicate more risk exposure.

Conclusion

It can be concluded that this study found support for the model of Wechsler et al. (2000), in which both personality and environment make unique contributions to drinking behaviour. Namely, results suggest that impulsive adolescents consume alcohol though alcohol exposure. For this reason, we suggest policy recommendations regarding alcohol exposure especially among schools and college, since adolescents might be more vulnerable for these cues due to their still

developing cognitive control (Wechsler et al., 2000). To better illustrate, alcohol stores or bars should not be too close located to for example the campus of an university. In addition, more research is suggested to focus on this topic in order to better understand the impact that risk exposure (e.g. alcohol exposure) has on adolescents risk-taking (e.g. alcohol use). In sum, since we found evidence for our real-world hypothesis only, it can only be stated that more alcohol exposure may lead to more alcohol consumption, whereas this cannot be stated regarding risk exposure and risk-taking on laboratory measure.

Appendix 1

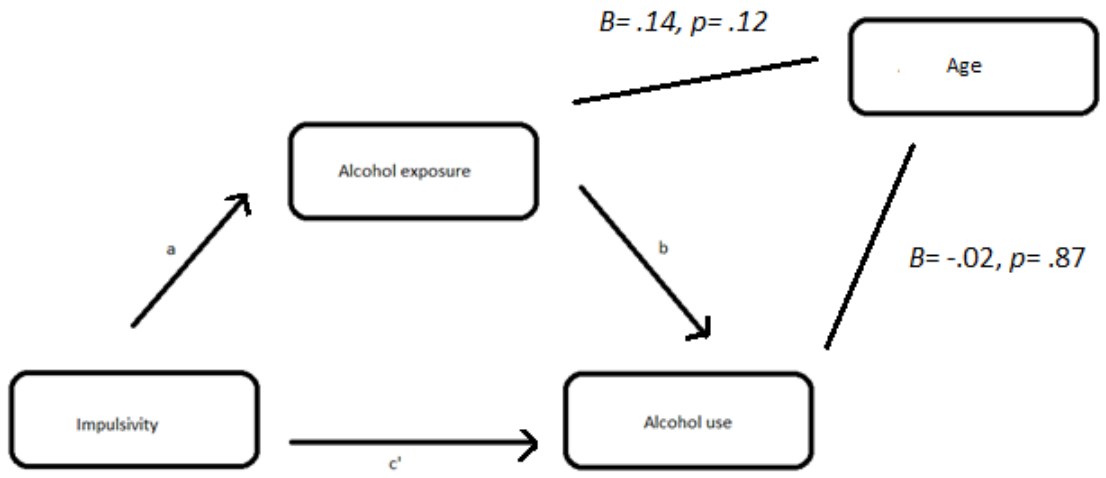

Figure 4. Mediation model with alcohol exposure as mediator, impulsivity as predictor, and age as covariate.

Reference list

Allen, M. (2017). Analysis of Variance (ANOVA). *The SAGE Encyclopedia of Communication Research Methods*. https://doi.org/10.4135/9781483381411.n15

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182. doi: http://dx.doi.org/10.1037/0022-3514.51.6.1173

Bulmer, M. (1979). Concepts in the Analysis of Qualitative Data. *The Sociological Review*, *27*(4), 651–677. https://doi.org/10.1111/j.1467-954X.1979.tb00354.x

Brown, M. R. G, Benoit, J. R. A., Juhás, M., Dametto, E., Tse, T. T., MacKay, M., … Greenshaw, A. J. (2015). fMRI investigation of response inhibition, emotion, impulsivity, and clinical high-risk behavior in adolescents. *Frontiers in Systems Neuroscience*, *9*. https://doi.org/10.3389/fnsys.2015.00124

Carroll, M. E., Anker, J. J., & Perry, J. L. (2009). Modeling risk factors for nicotine and other drug abuse in the preclinical laboratory. *Drug and Alcohol Dependence*, *104*, S70–S78. https://doi.org/10.1016/j.drugalcdep.2008.11.011

Centraal Bureau voor de Statistiek (CBS). (2016, December 15). Bevolking naar migratieachtergrond. Retrieved June 1, 2019, from https://www.cbs.nl/nl-nl/achtergrond/2016/47/bevolking-naar-migratieachtergrond

Defoe, I. N., Dubas, J. S., Figner, B., & van Aken, M. A. G. (2015). A meta-analysis on age differences in risky decision making: Adolescents versus children and adults. *Psychological Bulletin*, *141*(1), 48–84. https://doi.org/10.1037/a0038088

Defoe, I. N., Dubas, J.S., & Romer, D. (2019). Heightened Adolescent Risk-Taking? Insights From Lab Studies on Age Differences in Decision-Making. *Policy Insights from the Behavioral and Brain Sciences*, *6*(1), 56–63. https://doi.org/10.1177/2372732218801037

Eugene, B., Zechmeister, P., Shaughnessy, J. J., & Zechmeister, J. S. (2014). *Research Methods in Psychology*. McGraw-Hill Education.

Eysenck, S. B. & Eysenck, H. J. (1978). Impulsiveness and venturesomeness: their position in a dimensional system of personality description. *Psychological Reports, 43*(3f), 1247-1255. doi:10.2466/ pr0.1978.43.3f.1247

Figner, B., Mackinlay, R. J., Wilkening, F., & Weber, E. U. (2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia Card Task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *35*(3), 709–730. https://doi.org/10.1037/a0014983

Fernie, G., Peeters, M., Gullo, M. J., Christiansen, P., Cole, J. C., Sumnall, H., & Field, M. (2013). Multiple behavioural impulsivity tasks predict prospective alcohol involvement in adolescents. *Addiction*, *108*(11), 1916–1923. https://doi.org/10.1111/add.12283

GGD Nederland. (2018). *Gezondheidsmonitor Volwassenen en Ouderen, GGD'en, CBS en RIVM*. Retrieved from https://bronnen.zorggegevens.nl/Bron?naam=Gezondheidsmonitor-Volwassenen-en-Ouderen%2C-GGD%E2%80%99en%2C-CBS-en-RIVM

Gmel, G., Rehm, J., & Kuntsche, E. (2003). Binge-Trinken in Europa: Definitionen, Epidemiologie und Folgen. *SUCHT*, *49*(2), 105–116. https://doi.org/10.1024/suc.2003.49.2.105

de Graaf, R. (2017). *Factsheet alcoholintoxicaties 2007 tot en met 2016*. Retrieved from https://www.stap.nl/content/bestanden/factsheet-alcoholintoxicaties-2007-tot-en-met-2016_1.pdf

de Graaf, R. (2018). *Factsheet alcoholintoxicaties 2007 tot en met 2017*. Retrieved from https://www.volksgezondheidenzorg.info/sites/default/files/factsheet-alcoholintoxicaties-2007-tot-en-met-2017_0.pdf

Granö, N., Virtanen, M., Vahtera, J., Elovainio, M., & Kivimäki, M. (2004). Impulsivity as a predictor of smoking and alcohol consumption. *Personality and Individual Differences*, *37*(8), 1693–1700. https://doi.org/10.1016/j.paid.2004.03.004

Guerrieri, R., Nederkoorn, C., & Jansen, A. (2007b). The interaction between impulsivity and a varied food environment: its influence on food intake and overweight. *International Journal of Obesity*, *32*(4), 708–714. https://doi.org/10.1038/sj.ijo.0803770

Hayes, A. F. (2017). *Introduction to Mediation, Moderation, and Conditional Process Analysis, Second Edition: A Regression-Based Approach*. Retrieved from https://www.guilford.com/books/Introduction-to-Mediation-Moderation-and-Conditional-Process-Analysis/Andrew-Hayes/9781462534654/new-to-edition

IBM. (n.d.). Downloading IBM SPSS Statistics 25. Retrieved April 25, 2019, from https://www-01.ibm.com/support/docview.wss?uid=swg24043678

Jauregi, A., Kessler, K., & Hassel, S. (2018). Linking Cognitive Measures of Response Inhibition and Reward Sensitivity to Trait Impulsivity. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02306

Kahler, C. W., Read, J. P., Wood, M. D., & Palfai, T. P. (2003). Social environmental selection as a mediator of gender, ethnic, and personality effects on college student drinking. *Psychology of Addictive Behaviors*, *17*(3), 226–234. https://doi.org/10.1037/0893-164X.17.3.226

Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., … Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: The Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology: Applied*, *8*(2), 75–84. https://doi.org/10.1037/1076-898X.8.2.75

MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the Mediation, Confounding and Suppression Effect. *Prevention Science*, *1*(4), 173–181. https://doi.org/10.1023/a:1026595011371

Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods*, *44*(2), 314-324. doi:10.3758/s13428-011-0168-7

Maimon, D., & Browning, C. R. (2012). Underage drinking, alcohol sales and collective efficacy: Informal control and opportunity in the study of alcohol use. *Social Science Research*, *41*(4), 977–990. https://doi.org/10.1016/j.ssresearch.2012.01.009

McFatter, R.M. (1979) The Use of Structural Equation Models in Interpreting Regression Equations Including Suppressor and Enhancer Variables. *Applied Psychological Measurement*, *3*, 123-135. doi: http://dx.doi.org/10.1177/014662167900300113

Mozer, M. C. (2006). Rational Models of Cognitive Control. *Lecture Notes in Computer Science*, 20–25. https://doi.org/10.1007/11839132_2

Nower, L., Derevensky, J. L., & Gupta, R. (2004). The Relationship of Impulsivity, Sensation Seeking, Coping, and Substance Use in Youth Gamblers. *Psychology of Addictive Behaviors*, *18*(1), 49–55. https://doi.org/10.1037/0893-164X.18.1.49

Pedersen, S. L., & McCarthy, D. M. (2008). Person-environment transactions in youth drinking and driving. *Psychology of Addictive Behaviors*, *22*(3), 340–348. https://doi.org/10.1037/0893-164X.22.3.340

Penolazzi, B., Gremigni, P., & Russo, P. M. (2012). Impulsivity and Reward Sensitivity differentially influence affective and deliberative risky decision making. *Personality and Individual Differences*, *53*(5), 655–659. https://doi.org/10.1016/j.paid.2012.05.018

Richardson, G. B., Freedlander, J. M., Katz, E. C., Dai, C.-L., & Chen, C.-C. (2014). Impulsivity links reward and threat sensitivities to substance use: a functional model. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01194

Romer, D., Betancourt, L., Giannetta, J. M., Brodsky, N. L., Farah, M., & Hurt, H. (2009). Executive cognitive functions and impulsivity as correlates of risk taking and problem behavior in preadolescents. *Neuropsychologia*, *47*(13), 2916–2926. https://doi.org/10.1016/j.neuropsychologia.2009.06.019

Somerville, L. H., & Casey, B. J. (2010). Developmental neurobiology of cognitive control and motivational systems. *Current Opinion in Neurobiology*, *20*, 236-241. doi:10.1016/j.conb.2010.01.006

Stangor, C., & Walinga, F. (2014). *Introduction to psychology* (1st Canadian edition). BCcampus.

Steinberg, L. (2010). A dual systems model of adolescent risktaking. Developmental Psychobiology: *The Journal of the International Society for Developmental Psychobiology*, *52*(3), 216-224.

Trochim, W. (n.d.). Social Research Methods - Knowledge Base - Types of Reliability. Retrieved July 19, 2019, from http://www.socialresearchmethods.net/kb/reltypes.php

University of Minnesota. (2008). Grades In College Directly Linked To Health-related Behaviors. *ScienceDaily*. Retrieved April 15, 2019 from www.sciencedaily.com/releases/2008/10/081021120925.htm

Vitaro, F., Arseneault, L., & Tremblay, R. E. (1997). Dispositional Predictors of Problem Gambling in Male Adolescents. *American Journal of Psychiatry*, *154*(12), 1769–1770. https://doi.org/10.1176/ajp.154.12.1769

Wechsler, H., Kuo, M., Lee, H., & Dowdall, G. W. (2000). Environmental correlates of underage alcohol use and related problems of college students. *American Journal of Preventive Medicine*, *19*(1), 24–29. https://doi.org/10.1016/S0749-3797(00)00163-X

Zhao, X., Lynch, J. G., Jr., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *Journal of Consumer Research, 37*(2), 197-206. doi: http://dx.doi.org/10.1086/651257

Zuckerman, M., & Kuhlman, D. M. (2000). Personality and Risk-Taking: Common Bisocial Factors. *Journal of Personality*, *68*(6), 999–1029. https://doi.org/10.1111/1467-6494.00124