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Externalizing problem behaviour as predictor of cannabis use among adolescents

The influence of sensation seeking, self-control and fearlessness

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Abstract

Cannabis use is more dangerous than expected. It can lead to short- and long-term health problems. Using cannabis is perceived by adolescents as normal and the government is worried about the normalization of cannabis use. To limit the possible consequences as much as possible, early and effective interventions against cannabis use are essential. This study tested the effect of externalizing problem behaviour and the moderation effects of the three individual mechanisms sensation seeking, self-control and fearlessness on cannabis use. To analyze these relations, TRails data were used. A total of 2230 adolescents participated in this study (49.2% boys, M=11.09 years, SD= .59). The results from the hierarchical regression analysis, controlled for gender, showed no significant effect between externalizing problem behaviour and cannabis use. However, the main effects of high sensation seeking and low self-control were directly related to cannabis use. In sum, No relation was found between externalizing problem behaviour and the moderation effects of sensation seeking, self-control and fearlessness on cannabis use among adolescents. To gain more knowledge about individual mechanisms on cannabis use, further clinical research whether cannabis use might be typical for externalizing problems is needed.

Keywords: *externalizing problem behaviour, self-control, sensation seeking, fearlessness, cannabis use, adolescents*

Samenvatting

Cannabisgebruik is gevaarlijker dan wordt verwacht. Het kan leiden tot korte- en lange termijn gezondheidsproblemen. Jongeren zien cannabis als normaal en de overheid is daarom bang voor normalisering van cannabisgebruik. Om de gevolgen zo veel mogelijk te beperken, zijn vroege en effectieve interventies van belang. Deze studie onderzocht in hoeverre de relatie tussen externaliserend probleemgedrag en cannabisgebruik van jongeren wordt gemodereerd door zelfcontrole, spanningsbehoefte en onbevreesdheid. De studie maakte gebruik van een TRails onderzoek. 2230 jongeren namen deel aan dit onderzoek (49.2% jongens, M=11.09 jaar, SD= .59). De studievariabelen zijn onderzocht op basis van de YSR-schaal en CBCL-schaal. De resultaten van de hiërarchische regressie analyse, gecontroleerd voor gender, toonden geen significant effect aan tussen externaliserend probleemgedrag en cannabisgebruik. Er is echter wel een directe relatie gevonden tussen de hoofdvariabelen zelfcontrole en spanningsbehoefte op cannabisgebruik. Om meer inzicht te krijgen op de individuele factoren die van invloed zijn op cannabisgebruik is volgend onderzoek nodig om vast te stellen of cannabisgebruik typisch is voor externaliserend probleemgedrag.

Trefwoorden: *externaliserend probleemgedrag, zelfcontrole, spanningsbehoefte, onbevreesdheid, cannabisgebruik, adolescenten*

Introduction

Next to alcohol use, cannabis is one of the most common used drugs among adolescents in the Netherlands (Nationale Drug Monitor, 2016). According to the National Drug Monitor (2016) 22 percent of the Dutch students between 15-16 years old tried cannabis at least once in their lives. In Europe, this is 16 percent of the adolescents. Cannabis use is a social problem (Nationale Drug Monitor, 2016). Too much cannabis use can lead to short-term and long-term problems (Crean, Crane & Mason, 2011). A short-term problem of using cannabis is that it can lead to less motivation and a reduced concentration for school activities (Ter Bogt, Van Lieshout, Doornwaard & Eijkemans, 2009). Students who are less academically motivated, will easier skip classes or eventually drop out of school. A reduced concentration can therefore lead to less attention in classes, which in turn can lead to lower school achievements (Janosz,Le Blanc, Boulence, & Tremblay, 2000). A long-term problem of cannabis use can later lead to an addiction of cannabis and could enlarge the risk of developing a psychotic illness in the future (Rey, Martin, & Krabman, 2004). According to the meta-analysis of Moore and colleagues (2007), 40 per cent of the participants who had ever used cannabis had an increased risk for psychosis. Participants who used cannabis more often had 50 till 200 per cent more risk on a psychosis. Some other long-term mental and physical health issues include anxiety, depression, and increased damage to the lungs (Patton et al., 2002; Aldington et al., 2008). Next to the short- and long-term problems, using cannabis is perceived by adolescents as relatively normal and the government is worried about the normalization of cannabis use (Adviescomissie Drugsbeleid, 2009). Given these short- and long-term consequences and the normalization of cannabis use among Dutch adolescents, it is important to understand why adolescents use cannabis and what are possible predictors in this process.

Different individual factors for cannabis use have been identified in several studies (Wills, Pokhrel, Morehouse, & Fenster, 2011; Wilson & Scarpa, 2011; Hayatbakhsh et al., 2007). One of the predictors which may increase cannabis use is externalizing problem behaviour (Steele, Forehand, Armistead & Brody, 1995). Cannabis use is often seen among externalizing youth (Chan, Dennis & Funk, 2008). Besides externalizing behaviour, the individual factors self-control, sensation seeking and fearlessness have also been related to cannabis use (Wills, Walker, Mendoza, & Ainette, 2006; Crawford, Pentz, Chou, Li & Dwyer, 2003; Hicks, B. M., Iancono, W. G., & Mcgue, M., 2014). Although much is known about the

relationship between self-control, sensation seeking and fearlessness on cannabis use, less is known about the interacting role they play in the relation externalizing behaviour problems and cannabis use. Therefore this research will examine the relation between externalizing problem behaviour and cannabis use and will test whether other individual mechanisms such as self-control, sensation seeking and fearlessness moderates this relation.

Externalizing problem behaviour and cannabis use

Externalizing problem behaviour is characterized by aggressive (e.g. fighting), oppositional (e.g., running away) and delinquent (e.g., stealing & substance use) behaviour (Thijssen, 2016). In comparison with girls, boys engage more often in externalizing problem behaviour (Lewinsohn, Hops, Roberts, Seeley & Andrews, 1993). Several studies have shown that externalizing problem behaviour is associated with cannabis use (Fergusson, Horwood & Ridder, 2007; Hayatbakhsh *et al*., 2007). Adolescents with externalizing problem behaviour use more cannabis than adolescents without externalizing problem behaviour (Korhonen *et al*., 2010). In this research, the relation between externalizing problem behaviour and cannabis use will be examined. A hypothesis that can explain this relationship is the self-medication hypothesis (Khantzian, 1997). According to the self-medication hypothesis, the reason why adolescents with externalizing problems use cannabis is because it can contribute to a relieve of negative emotions It is possible that adolescents with externalizing problems use cannabis to calm down their anger (Khantzian, 1997). White, Xie, Thompson, Loeber, and Stouthamer-Loeber (2001) examined early psychopathology (study of mental illness) and behavioural problems, like violence behaviour and oppositional defiant disorder, as a predictor of trajectories of drug use and alcohol use. The longitudinal study examined student boys from ages 13 until 18 in England. To examine the trajectories of marijuana and alcohol use, they made use of self-reported data. The results showed that adolescents who have more behavioural problems will have higher levels of alcohol and use more marijuana. In other words this study concludes that early externalizing behaviour is a predictor of marijuana use. Also other studies mention that externalizing problem behaviour is a predictor of cannabis use (Fergusson et al., 2007; Griffith-Lendering, Huijbregts, Mooijaart, Vollebergh & Swaab, 2011; Goodman, 2010; Hayatbakhsh et al., 2007; Frick et al., 1993). Griffith-Lendering and colleagues (2011) examined the prospective relation between externalizing and internalizing problems and cannabis use. In this study, Dutch

adolescents between 11-16 years were followed. The results showed an association between externalizing problem behaviour and cannabis use. Young adolescents with externalizing problem behaviour at age eleven more likely used cannabis at the age of 13 and 16. Also, adolescents with externalizing behaviour at age of thirteen used more cannabis at age sixteen.

Altogether, the literature above suggests that externalizing problem behaviour is related to cannabis use. Therefore, it is plausible to assume a positive relation between adolescents with externalizing problem behaviour and cannabis use.

Sensation-seeking, self-control and cannabis use

Sensation seeking as well as self-control appears to be related to cannabis use and might moderate between externalizing problem behaviour and cannabis use. The dual systems model could explain this relation (Steinberg et al., 2008). This model explains risk-taking behaviour, such as cannabis use, as a result of an imbalance between two information processing systems: the socioemotional system and the cognitive control system. The socioemotional system can be seen as a unconsciously automatic driving force. It responds intuitive to emotions, novelty, and reward stimuli and automatically leads to a certain behaviour (Frankish & Evans, 2009) Impulsivity and sensation seeking can be seen as under controlled personality traits and are related to socioemotional system (Steinberg *et al*., 2008). The cognitive control system can be seen as a consciously controlled driving force. It allows to suppress your impulses and helps to make decisions based on desires (Kouneiher, Charron, & Koechlin, 2009). Risk-taking behaviour is a result of a fast socioemotional system and/or a slow cognitive control system. Thus, adolescents with lower self-control and higher sensation seeking tendencies are more likely to engage in risky behaviour, like cannabis use.

Sensation seeking refers to an individual desire for the intense novel, highly stimulating activities and experiences (Zuckerman, 1994). One of the factors that can influence the tendency for sensation seeking is externalizing problem behaviour (Wilson & Scarpa, 2011; Joireman, Anderson, & Strathman, 2003). Adolescents with more aggression, tend to have higher levels of sensation seeking (Wilson & Scarpa, 2011). Sensation seeking has been associated with risk-taking behaviour like shoplifting, sexual behaviour and, binge drinking (Arnett, 1994). Sensation seeking is also strongly associated with experimenting with drugs and several studies have found that sensation seeking predicts drug use during adolescence (Arnett, 1994; Leeman, Hoff,

Kristman-Sarin, Patock-Peckham, & Potenza, 2014; Martin et al., 2002). Crawford and colleagues (2003) examined whether the development of sensation seeking predicted the development of substance use and alcohol use among adolescents. The study evaluated two different samples of adolescents in middle school and high school. The results showed that in both samples a low sensation seeking in middle school was a strong predictor of marijuana use in high school. One study included the externalizing problem behaviours among adolescents in their research The study of Simon, Stacy, Sussman, and Dent (1994) examined the drug use among externalizing Latino and Anglo adolescents.with high levels of sensation seeking. They found that high risk adolescents with high levels of sensation seeking used more drugs compared to adolescents with low levels of sensation seeking.

In conclusion, the association of sensation seeking with both cannabis use and externalizing behaviour of adolescents makes it plausible that the relation between externalizing problem behaviour and cannabis use could be even stronger for those who have higher levels of sensation seeking.

Besides sensation seeking, self-control is also found as a predictor of cannabis use (Baron, 2003; Chapple, Hope, & Whiteford, 2005). Self-control is the ability to control impulses and to resist temptations (Baumeister, 1998). Low self-control can lead to risk-taking behaviour, like alcohol and cannabis use (Peeters, Oldehinkel & Vollebergh, 2017; Wills et al., 2006). The study by Verdejo Garcia and colleagues (2008) examined if self-control was a marker for substance use disorder. The results showed that self-control is associated with the vulnerability to drug use and dependence.

Low self-control is not only associated with cannabis use but also with externalizing problems (Gottfredson and Hirsch, 1990; Eisenberg et al., 2009). Externalizing youth often have difficulties with controlling impulses (Hart, Burock, London, Atkins, & Bonilla-Santiago, 2005). Gottfredson and Hirschi (1990) argue that adolescents with delinquent problem behaviour have a lower self-control. Those adolescents cannot control themselves and are less likely to consider the long-term consequences of their behaviour. Also, Eisenberg and colleagues (2009) concludes that self-control is low in problem behaviours, especially externalizing problem behaviour. One study includes externalizing problem behaviour as well as self-control and cannabis use in one study (Baron, 2003). The study measured the criminal involvement (e.g., stealing and fighting), the self-control and the drug use among 400 homeless street youth. The results of the study

showed that adolescents with criminal behaviour who had a low self-control used more drugs compared to adolescents with criminal behaviour who had higher self-control.

To summarize, the results indicated that self-control could interact in the relation between externalizing problem behaviour and cannabis use. Based on the results above and translated to the current study, it is expected that the relation between externalizing problem behaviour and cannabis use could be even stronger for those who have difficulties with self-control.

Fearlessness and cannabis use

Fearlessness, also known as a lack of fear, is a third factor that can predict cannabis use. Fearless adolescents are more likely to engage in risk-taking behaviour like cannabis use. One of the reason is that fearless children do not fear the consequences of what they do (Raine, Reynolds, Venables, Mednick, & Farrington, 1998). Adolescents who exhibit delinquent behaviour are according to Lochman and Dodge (1994) less inhibited by fears. Therefore, they are more likely to engage in risk-taking behaviour, such as smoking cannabis. A possible explanation why those adolescents who are more fearless have a more stimulation seeking trait is because of their lower resting heart rate (Raine et al., 1998; Valois, MacDonald, Bretous, Fischer, & Drane (2002). Adolescents revealing aggressive behaviour have low arousal. A low arousal has been linked to fearlessness and stimulation seeking behaviour (Raine et al., 1998; Wilson & Scarpa, 2011). Fearlessness could also influence the use of cannabis (Brook, Whiteman, Cohen, Shapiro and Balka, 1995). According to Brook and colleagues (1995) fearlessness is associated with an increase of substance use. They examined the personality traits and drug use in childhood and adolescence. In this longitudinal study, data were obtained when the children were around 5, 14, 16 and 22 years old. The results showed that fearlessness, as a personality trait in adolescence, led to more drug use in adolescence. According to Wagner (2001) fearlessness is related to externalizing problem behaviour as well as substance use. In this study they examined the anxiety sensitivity, the delinquent behaviour and the substance abuse of undergraduate students. They expected that high anxiety sensitivity predicts more substance abuse. On the contrary, the result showed that low anxiety sensitivity (fearlessness) predicts substance abuse. They also found that these undergraduate students with delinquent behaviour were more likely to abuse substance. This could mean that the relation between externalizing

problem behaviour and cannabis use could be even stronger for adolescents who fear less anxiety.

In conclusion, the association of fearlessness with both cannabis use and externalizing behaviour of adolescents makes it plausible that the relation between externalizing problem behaviour and cannabis use could be even stronger for those who have low anxiety.

Present study

This current longitudinal study evaluates whether the individual mechanisms sensation seeking, self-control and fearlessness could moderate the relation between externalizing problem behaviour and cannabis use. In the first place, this study examines the relationship between externalizing problem behaviour and cannabis use by adolescents (figure 1). Based on previous research it is assumed that externalizing problem among adolescents leads to more use of cannabis. Secondly, this study evaluates whether sensation seeking, self-control and fearlessness influences the relation between externalizing problem behaviour and cannabis use. It is expected that adolescents with a higher trait of sensation seeking and fearlessness and a lower self-control will use more cannabis. The current study aims to increase the knowledge about moderation factors in the relation between externalizing problem behaviour and cannabis use. To the best of our knowledge there are no previous studies that have evaluated whether sensation seeking, self-control and fearlessness moderate the relationship between externalizing problem behaviour and cannabis use altogether in one study. Since boys show more externalizing problem behaviour compared to girls (Lewinsohn et al., 1993) sex will be included as control variable in the analyses.

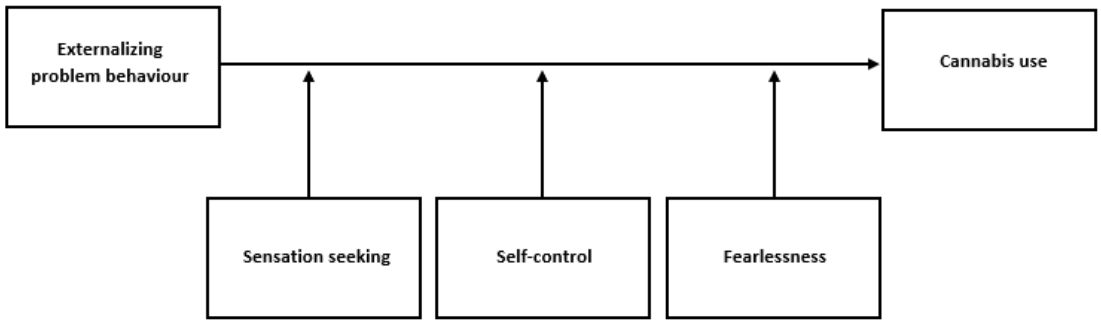

Figure 1. Theoretical framework

Method

Participants

Data used in this study came from the TRAILS (TRacking Adolescents' Individual Lives Survey). TRAILS followed adolescents from the age of 11 until at least the age of 24. In the first wave (T1) 2230 adolescents (49.2% boys and 50.8% girls, M=11.09 years, SD= .59) participated. Two to three years after T1, the second wave (T2) was conducted among 2146 (96.2%) adolescents (48.8% male, M= 13.6 years, SD=0.53). The third wave (T3) was conducted about one to four years after T2 among 1816 (84.6%) adolescents (47,7% male, M= 16.3 years, SD=0.73). In this study, the second (T2) and third wave (T3) were used.

Procedure

The participants of the TRAILS target sample are adolescents who are living in five municipalities in the North of the Netherlands, including both urban and rural areas. The municipalities were requested to give the names and addresses of all inhabitants who were born between 10-01-1989 and 09-30-1990 or 10-01-1990 and 09-30-1991, giving a total of 3483 names. Thereafter, primary schools were approached with the request to participate in the TRAILS research. When the schools approved to participate, parents received one brochure for themselves and one for their children. Parental permission was obtained through an interview in which parents were asked to sign an informed consent form. During the measurements, well-trained interviewers visited parents or guardians to conduct an interview on a wide range of topics. Besides the interview, parents and guardians were asked to fill out a self-report questionnaire. The adolescents were assessed at school, where they filled in questionnaires. Lastly, teachers were asked to fill in a brief questionnaire for all TRAILS-children in their class (Oldehinkel et al., 2014).

Measures

Cannabis use. Cannabis use, the dependent variable, is measured by the number of occasions (e.g., at home, at a party) on which cannabis was consumed in the last twelve months (Creemers et al., 2011). At T2 and T3, adolescents were asked if they used drugs in the past 12

months. Because of the wide range of response options, the variable was recoded. The answer categories ranged from 0 till 40 times or more (0–10; 11–19; 20–39; 40 or more).

Externalizing problem behaviour. Externalizing problem behaviour, an independent variable, was measured based on two constructs. These constructs were aggressive behaviour and delinquent behaviour. The scale was based on the manual for the Youth Self-Report (Achenbach, 1991). The scale consisted of 32 items, including risk-taking behaviour as alcohol use, drug use and tobacco use. To operationalize cannabis use, the three substance use-behaviours were left out because these may would have biased the results. The 29 items of externalizing problem behaviour were scored on a 3-point Likert scale (0= never, 1= sometimes, 2= a lot). One of the questions in the scale was "I did not obey my parents". It is important to notice that the externalizing problems used in this study were not diagnosed but YSR subscales that are based on questions that correspond to DSM IV criteria.

Sensation seeking. Sensation seeking was operationalized with the child version of the excitement seeking scale, based on the NEO Personality Inventory (NEO-PI-R) (Costa & McCrae, 1992). Excitement seeking scale consisted of 8 items and was scored on a 5-point scale (1= never true, 5= always true). Items included questions as: "I did things only because of the excitement kick". The Cronbach's alpha was .58. the mean of the variable is based on the sum score instead of an average of a 5-point Likert scale.

Self-control. Self-control was operationalized with the parent version of the effortful control scale, based on the Early Adolescent Temperament Questionnaire (Putnam, Ellis & Rothbart, 2006). The effortful control scale consisted of 11 items. One of the questions was: 'If my child is disrupted, he/she forget what he/she would say'. The parents could give an answer on a 5-point Likert scale, from 1= never true till 5= almost always true. The Cronbach's alpha of the items self-control was .86.

Fearlessness. Fearlessness was operationalized with the parent version by measuring the fear of the adolescents. The scale was based on the Early Adolescent Temperament Questionnaire (Putnam et al., 2006). The scale existed of 5 items. An example of a question which operationalized fearlessness was: "My child worries if he/she would be in trouble.". The parents could select from a 5-point Likert scale from 1 till 5 (1= always, 5= never). The Cronbach's alpha of the items fearlessness was .66.

Data analysis

The data were analyzed using IBM SPSS statistics 24. In this study, an attrition analysis was conducted to compare missing data on wave 2 and wave 3. Study variables on wave 2 were analyzed with an independent t-test. 299 Adolescents, 138 girls (46.2%) and 161 boys (53.8%) who used cannabis at T2 dropped out. The adolescents who participated at wave 3 scored lower on cannabis use (M= .28, SD= 2.31) than adolescents who dropped out (M= .73, SD= 4.52). For externalizing problem behaviour at wave 2 there was almost no difference between the adolescents who dropped out and who participated. An independent t-test was performed to examine the significance level of the dropouts. It was found that cannabis use at T2 was significantly lower in the group that was missing ($p<.01$, $t= -1.69$, $df= 325.20$). For externalizing problem behaviour no significant difference was found between the group who participated and who dropped out ($p= .93$, $t= -0.32$, $df=1908$). Besides missing variables, outliers were checked. Outliers were found in the data, especially in the variable 'cannabis use'. However, the outliers were included for further analyses, because they gave important information about the predictor cannabis use by adolescents. Descriptive statistics (Mean and SD) were requested to get a better insight in the variables externalizing problem behaviour, sensation seeking, self-control, fearlessness. and cannabis use. A Pearson correlation was conducted to examine the relation between the variables. After the Pearson correlation, the assumptions of a hierarchical multiple regression analysis were checked. The data of cannabis use were not normally distributed because the average use of cannabis was low. Despite a skewed distribution a hierarchical multiple regression analysis was used to test the hypotheses about the use of cannabis. In the first step cannabis use at T2 and covariate gender were included. In step 2 the study variables self-control, sensation seeking and fearlessness were added. Finally, in step 3 the three interaction variables were included. Hereby the study variables externalizing problem behaviour, self-control, sensation seeking, and fearlessness were centered and the interaction variables were independently examined.

Results

Descriptive statistics

Table 1 includes an overview of the N, mean (M), SD and minimum and maximum for study variables at T2 and T3. Only for sensation seeking a sum square was used. The Table presents a low average for cannabis use at T2 and T3. The mean score of externalizing problem behaviour is not higher than one. The study variables sensation seeking and cannabis use T3 show a higher SD than other variables, indicating bigger differences between the scores.

Table 1

Descriptive statistics of study variables

	N	M (SD)	Min	Max
Sex	2230	0.49 (0.50)	0	1
Externalizing problem behaviour	1910	0.30 (0.21)	0	1.38
Cannabis T2	2042	0.35 (2.75)	0	40
Self-control	1510	3.20 (0.66)	1.27	5
Sensation seeking	1658	27.80 (4.18)	12	39
Fearlessness	1505	1.94 (0.64)	1	4.40
Cannabis T3	1634	2.86 (8.44)	0	40

Table 2 represents the correlations between the study variables. 3 out of the 5 studied variables show a significant relation with cannabis use at T3. These variables are self-control, sensation seeking and cannabis use at T2. Self-control is negative correlated with cannabis use at T3 ($r = -.20$, $p < .01$). Adolescents with a higher self-control tend to have a lower use of cannabis. Sensation seeking, on the other hand, is positively correlated with cannabis use ($r = .19$, $p < .01$). Adolescents with a high level of sensation seeking use more cannabis compare to adolescents

with lower levels of sensation seeking. Besides sensation seeking, cannabis use at T2 is also positively correlated with cannabis use at T3 (r= .17, p< .001). Adolescents who use cannabis at T2 used more cannabis at T3. The covariate gender is positive correlated with cannabis use at T3 (r= .16, p< .01). Besides the significant correlations between the dependent and independent variables, there are also significant correlations between the independent variables. Table 2 shows a negative relation between self-control and sensation seeking (r= -.12, p <.01). Self-control (r= -.19, p <.01) and sensation seeking (r= = .9, p <.01) in relation with fearlessness also show a negative significant relation. Sex correlated with self-control, with boys scoring lower at self-control than girls (r= -.24, p < .01).and fearlessness with boys scoring higher at fearlessness than girls (r= -0.13, p < .001).

Table 2

Pearson correlations for all study variables for the total sample

	1	2	3	4	5	6	7
Gender	1						
EPB	-.01	1					
Cannabis use (T2)	.04	-.00	1				
Self-control	-.24**	-.02	-.05	1			
Sensation seeking	.18**	.04	.03	-.12**	1		
Fearlessness	-.13**	.01	-.01	-.19**	-.09**	1	
Cannabis use (T3)	.16**	-.03	.17**	-.20**	.19**	.01	1

***. Correlation is significant at the 0.01 level (2-tailed)*

Note. EPB= externalizing problem behaviour

Hierarchical multiple regression analysis

A hierarchical multiple regression analysis is represented in Table 3. With respect to cannabis use (T3), cannabis use at T2 significantly predicts cannabis use at T3 (ΔR^2 = *.05*, ß = 0.75, SE= 0.11). Besides cannabis use at T2, self-control also predicts an increase in cannabis use (ΔR^2= *.08,* ß = -2.23, SE= 0.39). Adolescents with poor self-control increase stronger in cannabis use compare to adolescents with good self-control. In addition, sensation seeking at T2 predicts cannabis use at T3 (ΔR^2= *.07*, ß = 0.31, SE= 0.06). In contrast to what was expected, externalizing problem behaviour and fearlessness do not significantly predict cannabis use at T3. For the three interaction effects, also no effects on cannabis use at T3 is found.

Table 3

Regression coefficients for main and interaction effects, with cannabis use at T3 as outcome measure

	ß	SE	p-value (2-tailed)	95% BHI
Main effects				
Gender	2.82	0.42	.00	2.00 – 3.64
Cannabis T2	0.75	0.11	.00	0.53 – 0.96
EPB	-1.35	1.19	.26	-3.70 – 0.99
Self-control	-2.23	0.39	.00	-2.98 – -1.47
Sensation seeking	0.31	0.06	.00	0.21 – 0.43
Fearlessness	0.48	0.39	.22	-0.29 – 1.26
Interaction effects				
EPB * self-control	2.33	1.75	.18	-1.11 – 5.76
EPB * sensation seeking	-0.28	0.26	.28	-0.80 – 0.23
EPB * fearlessness	-0.02	1.87	.99	-3.69 – 3.64

Note. EPB= externalizing problem behaviour

Discussion

The main goal of this longitudinal study was to obtain more insight into the relation between externalizing problem behaviour and cannabis use among adolescents and the moderation effects of self-control, sensation seeking and fearlessness. The results showed no direct or indirect relation between externalizing problem behaviour and cannabis use. However, self-control and sensation seeking were found to be directly related to cannabis use.

Externalizing problem behaviour on cannabis use

This longitudinal study assessed the relation of externalizing problems and the moderation effects of sensation seeking, self-control and fearlessness on cannabis use among adolescents from 10 until 18 years of age. The results showed neither a direct or indirect effect on externalizing problem behaviour and cannabis use. Externalizing problem behaviour was not a predictor of cannabis use at T3. Because no effect was found a cross-sectional study was conducted. The cross-sectional study also did not show a significant effect between externalizing problem behaviour and cannabis. This result is in contrast with what has been found in most previous studies (Fergusson et al., 2007; Griffith et al., 2011; Goodman, 2010; Hayatbakhsh et al., 2007; Frick et al., 1993). This opposite result may be explained by the operationalization of externalizing problem behaviour.

First, the scale of externalizing problems can be seen as explanation for the non-significant effect of externalizing problems on cannabis use. In this study externalizing problem behaviour was measured only by using the YSR-scale. Other studies who did find a significant result measured externalizing problem behaviour with two scales (either YSR and CBCL or YSR and TRF)(Hayatbakhsh et al., 2008; Korhonen et al., 2010; Weeks et al., 2016). Besides the used scale a second explanation for no significant result between externalizing problems and cannabis use, can be seen in the differences concepts of externalizing problems. According to Timmermans, Van Lier, and Koot (2008), the concept externalizing problem behaviour includes several behaviours, like aggressive and delinquent behaviour. Thus, it depends which externalizing problem behaviour will be examined. The study of Korhonen and colleagues (2010) measured externalizing problem behaviour with 120 items and externalizing problems was operationalized as a score of conduct disorder, attention deficit disorder and oppositional

disorder. It is possible that this study found an effect because they operationalized externalizing problems differently than how it was done in this study. A third possible explanation could be that previous studies on this subject did not leave the three substance use-behaviours out of their analysis (tobacco use, drug use and alcohol use (Hayatbakhsh et al., 2008). There are also studies of which it is not clear whether externalizing problems are operationalized with or without the three substance-use behaviours included in their analyses. If those studies included these three behaviours, there is a possibility that they biased the results. In their study to this subject, Miettunen and colleagues (2014) did not find a relation between externalizing problem behaviour and cannabis use. This study operationalized externalizing problem behaviour with 29 items of the YSR-scale (excluding the three substance-use behaviours). While no relation was found and drug use was excluded, it might suggest that cannabis use is not a part of externalizing problem behaviour. To analyse whether this could be a possible explanation, additional analyses were executed. A cross-sectional study was conducted to examine if externalizing problem behaviour predicted cannabis use. Just like the longitudinal research, the cross-sectional design did not find a significant effect. However, if there was no relation found between externalizing problems and cannabis use, why is drug use like cannabis use operationalized as an item of externalizing problem behaviour? Can cannabis use be a part of externalizing problem behaviour? These inconsistencies demands for further research.

Besides the operationalization of externalizing problem behaviour there were also explanations found in cannabis use that may cause the non-significant relation between externalizing problems and cannabis use. A first explanation could be that there was not much variance in the use of cannabis to find an effect. between externalizing problems and cannabis use. This might have to do with the young sample that is used in this study. According to Verdurmen *et al*. (2012), the mean age of smoking cannabis is 14.3 years old. One out of 20 adolescents of the age of 13 has tried cannabis at least once in their lives. At the age of 16, this is approximately 32% of the adolescents. In this study approximately 6% of the adolescents tried cannabis (M=13.6). At the age of 16, this was approximately 25% of the adolescents. Because this study used a low mean-age sample of cannabis further research should consider a sample of adolescents at the age of 16 or older.

Secondly a rural community sample could be an explanation for the low variance in the use of cannabis. A non-significant effect of externalizing problem behaviour and cannabis use,

might has to do with the young sample that is used in this study. The participants of this study are adolescents who are living in five municipalities in the North of the Netherlands. According to previous studies, cannabis is smoked more often by adolescents in the larger cities than in rural area (CBS, 2009). This could mean that the mean-score of cannabis use is not generalizable for all adolescents.

Summarized, this study did not find a relation between externalizing problem behaviour and cannabis use. It is possible that the given explanation could be a reason for this effect. Because no direct relation was found, no moderation effects of sensation seeking, self-control and fearlessness on cannabis use were found.

Sensation seeking and self-control on cannabis use

In this study no result was found between externalizing problem behaviour and the moderation effect of sensation seeking, self-control and fearlessness on cannabis use. However, we did find a result between sensation seeking and self-control on cannabis use. Sensation seeking was a significant predictor of cannabis use at T3. Adolescents with a higher levels of sensation seeking indicated more cannabis use compared to adolescents with a lower level of sensation seeking. These findings are in line with previous studies (Arnett, 1994; Leeman et al., 2014; Martin et al., 2002). The significant result between sensation seeking and cannabis use can be explained by the Zuckerman's sensation-seeking theory (Zuckerman, 1978). According to the sensation-seeking theory adolescents with a higher level of sensations are more looking for risk-taking behaviour than adolescents with a lower level of sensations. Because high sensation seekers are more excited and more thrilled to do something risky, such as experimenting with cannabis.

Besides sensation seeking, self-control is also related to cannabis use. This result is in line with previous studies (Peeters et al., 2017; Wills et al., 2006). With respect to self-control it was found that weaker self-control predicted more cannabis use at age 16. Adolescents with lower self-control have more difficulties to control their behaviour in tempting situations such as is the case with cannabis use. According to the dual systems model (Steinberg et al., 2008) risk-taking behaviour is a result of an imbalance between two information processing systems: the

socioemotional system and the cognitive control system. A low cognitive control and a high socioemotional system can lead to risk-taking behaviour like experimenting with cannabis.

Thus, the result of this study indicates that sensation seeking as well as self-control predict increase in cannabis use two years later. However, there was no support for the interacting influences for these variables on the relationship between externalizing problem behaviour and cannabis use.

Fearlessness and cannabis use

In this study no moderation effect of fearlessness between externalizing problem behaviour and cannabis use was found. Furthermore, no direct link was found between fearlessness and cannabis use. These results were in contrast with what was expected. Previous studies suggested that low fear leads to more cannabis use (Brook et al., 1995). A possible explanation could be the low reliability (a = 0.63) of the subscale fearless. Usually, a Cronbach's alpha of 0.7 can be seen as acceptable. The higher the score is, the more reliable the scale (Tavakol & Dennick, 2011). Future research could benefit from including other measures of fearlessness while investigating its interacting influence with externaling problem behaviour and cannabis use.

Strengths and Limitations

This study has several strengths such as a large representative sample (n>1000), and it is a longitudinal design. However, there are also some limitations. First of all, the use of self-reports by parents and adolescents. Because in this study only self-report and report from parents were used, no statement can be made about the actual presence of a disorder. According to previous studies, self-reports of cannabis are generally valid (Murray & Perry, 1987; Creemers et al., 2009). However, there is a possibility that the nature of the questions could have led to socially desirable answers among adolescents. Another limitation is the area in which the sample was taken. The participants of the TRails target sample are adolescents who are living in five municipalities in the North of the Netherlands. According to previous studies, cannabis is smoked more often by adolescents in the larger cities compared to rural areas (CBS, 2009). Therefore, it is possible that these adolescents of this study smoked less cannabis than average

adolescents and therefore results are not generalizable to other samples. At last, the non-significant relation between externalizing problems and cannabis use can possibly be explained by the non-clinical sample used in this study. Future research should also consider clinical samples.

Conclusions and implications

In this study no moderation effects of sensation seeking, self-control and fearlessness were found between externalizing problem behaviour and cannabis use. Although no moderation effect was found, sensation seeking and self-control were found as predictors of cannabis use two years later. Moreover, since no relation between externalizing problem behaviour and cannabis was found, further research whether cannabis use might be typical for externalizing problembehaviour is warranted. Particularly because validated scales such as the YSR include items on drugs as indicator for externalizing problem behaviour. The question however is whether such an item should be included as identifying externalizing problem behaviour, therefore further research is needed. In addition, it is important to look in clinical sample as well. Since this study used a non-clinical sample, it was not certain if those adolescents who scored on externalizing problem behaviour had externalizing problems.

In short, using cannabis is seen by adolescents as normal and the government is worried about the normalization of cannabis use (Adviescommissie Drugsbeleid, 2009). To limit the possible consequences as much as possible in an early stage, further clinical research whether cannabis use might be typical for externalizing problems is needed.

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