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The Relationship Between Self-Regulation and Adolescents' Cannabis Use:

The Moderating Effect of Affection to Parents, Teachers and Classmates

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Abstract

Cannabis use among adolescents is associated with multiple health- and behavioural problems. In this longitudinal study it is investigated if high levels of self-regulation lead to less cannabis use (lifetime use, age at onset and frequency), and if affection to parents, teachers and classmates enhances this effect of a high self-regulation. The current study uses data of the TRacking Adolescents' Individual Lives Survey (TRAILS), consisting of 1612 adolescents with an average age of 10.57 (range = 2) years old at the first measurement. Self-regulation consists of self-control and effortful control and is measured by teacher-, parents- and self-report. High self-reported effortful control is associated with less lifetime use and less frequent use. High teacher-reported self-control and high affection to teachers are both associated with less lifetime use and a later age at onset. No interaction effects were found, except for affection to parents on the relationship between parent-reported self-control and frequency of use. The results show the importance of enhancing self-regulation for adolescents to prevent cannabis use. Future research needs to investigate which factors, besides affection, in the social environment of adolescents could affect the relationship between self-regulation and cannabis use.

Key words: cannabis, self-control, effortful control, self-regulation, affection, adolescents

Samenvatting

Cannabisgebruik van adolescenten kan leiden tot gezondheids- en gedragsproblemen. In dit longitudinale onderzoek wordt gekeken of een hoge mate van zelfregulatie leidt tot minder cannabisgebruik (ooit gebruikt, de startleeftijd en frequentie), en of affectie voor ouders, leraren en klasgenoten deze relatie versterkt. De huidige studie maakt gebruik van data afkomstig uit de 'TRacking Adolescents' Individual Lives Survey' (TRAILS), bestaande uit data van 1612 adolescenten van gemiddeld 10.57 (range = 2) jaar oud op het eerste meetmoment. Zelfregulatie bestaat uit zelfcontrole en effortful control en is gemeten door ouders, leraren en adolescenten zelf. Hoge zelf-gerapporteerde effortful control is gerelateerd aan minder ooit gebruik en een lagere frequentie. Zowel hoge leraren-gerapporteerde zelfcontrole als hoge affectie voor leraren zijn gerelateerd aan minder ooit gebruik en een latere startleeftijd. Er werd alleen een interactie effect gevonden voor affectie voor ouders op de relatie tussen door ouders-gerapporteerde zelfcontrole en frequentie van cannabisgebruik. De resultaten laten zien dat het stimuleren van een hoge zelfregulatie bij adolescenten belangrijk is om cannabis gebruik te voorkomen. Vervolgonderzoek moet uitwijzen welke andere factoren uit de sociale omgeving van adolescenten de relatie tussen zelfregulatie en cannabis gebruik beïnvloeden.

Trefwoorden: cannabis, zelfcontrole, effortful control, zelfregulatie, affectie, adolescenten

Cannabis use among adolescents is associated with an extensive range of problems related to health and behaviour. Cannabis has a harmful effect on the maturation of the adolescent brain, contributes to the development of psychotic disorders in adulthood such as schizophrenia and is associated with aggressive and delinquent behaviour (Arseneault et al., 2002; Lynskey, Coffey, Degenhardt, Carlin, & Patton, 2003; Monshouwer et al., 2006). In the Netherlands, one in five adolescents younger than 16 years old has used cannabis once. Almost a quarter of this group used cannabis at least nine times the past month (Van Laar et al., 2017). It can be concluded that cannabis use is harmful for adolescents. Therefore, it is important to understand which factors contribute to the onset and frequency of adolescents' cannabis use.

Previous empirical studies showed that adolescents' cannabis use is influenced by individual factors, including the ability to self-regulate emotions, attention and behaviour (Peeters, Oldehinkel, & Vollebergh, 2017; Wills, Walker, Mendoza, & Ainette, 2006). Besides individual factors, the social environment also influences adolescents' cannabis use. Affective ties with key individuals such as parents, teachers and peers affect the behaviour of adolescents. Strong affective connections result in a better adaption to the norms and values of society, and may therefore reduce cannabis use (Hawkins & Weis, 1985). Moreover, previous research indicated an interplay between individual characteristics and the social environment, influencing adolescents' risk-taking behaviour (Brendgen, 2012; Kochanska, Philibert, & Barry, 2009). Therefore, it is plausible that strong affective ties with key individuals in the social environment of adolescents moderate the relationship between self-regulation and cannabis use.

The current longitudinal study addresses the relationship between self-regulation and adolescents' cannabis use (i.e. lifetime use, age at onset and frequency), and the moderating effect of affection to parents, teachers and classmates. This study contributes to the existing scientific knowledge by using an extensive perspective on self-regulation. Different measures of self-regulation (i.e. self-control and effortful control) are used in one design, to ensure a complete understanding of the issue. Moreover, multiple informants are considered (parents, teachers and self-report). This study will provide new insights into the relationship between self-regulation and cannabis use, and the role of affective ties with key individuals in this process. This contributes to our knowledge about factors influencing adolescents' cannabis use and clarifies if a focus on both individual factors and the social context of adolescents in interventions can be effective.

Self-regulation and cannabis use

Self-regulation refers to the capacity to regulate emotions, attention and behaviour (Peeters et al., 2017), and is influenced by genetic predisposition as well as environmental factors (Kochanska et al., 2009). Self-regulation is an umbrella term for the concepts self-control and effortful control. The terms self-control and effortful control are often used interchangeably, but sometimes a distinction is made. Effortful control refers to the capacity to regulate behaviour and attention voluntarily (Creemers et al., 2010). For example, the ability to concentrate on homework. Self-control is the ability to resist opportunities for simple activities believed to provide immediate rewards (Desmond, Bruce, & Stacer, 2012), such as staying calm in a conflict. This suggests that effortful control refers to the ability to consciously manage attention and behaviour, while self-control is about controlling impulses. Although a difference between both constructs can be made, theory is mostly applicable on both self-control and effortful control.

According to the General Theory of Crime (Gottfredson & Hirschi, 1990), individuals lacking internal control are more likely to exhibit criminal behaviour, regardless other personality characteristics. Individuals low on self-control are less competent in resisting the natural motivation to engage in behaviour reducing pain and increasing pleasure, such as delinquent behaviour and substance use. They are impulsive and focused on simple, risk-taking behaviour providing immediate gratification of desires, without considering the negative long-term consequences of their acts. Criminal behaviour provides direct pleasure, equal to the use of substances such as cannabis. Self-control skills affect adolescents' ability to consider the negative consequences of cannabis use (Desmond et al., 2012; Gottfredson & Hirschi, 1990). Therefore, it is expected that the ability to self-regulate behaviour and emotion influences adolescents' onset and frequency of cannabis use.

Previous studies have confirmed this relationship between self-regulation and cannabis use. Most longitudinal studies on self-regulation and substance use focus on one construct of self-regulation: self-control (Wills & Stoolmiller, 2002; King, Fleming, Monahan, & Catalano, 2011; Griffith-Lendering et al., 2011; Desmond et al., 2012; Ragan & Beaver, 2010). Self-control is reflected in many behaviours, and therefore these studies differ in their methods used to measure self-control. Desmond and colleagues (2012) measured self-control by self-report on temper, impulsivity, preference for physical activities, decision making and problem solving. Wills and Stoolmiller (2002) measured self-control by self-reports and teacher-reports on impatience, distractibility and anger. Self-reports and teacher-reports were analysed independently. King and colleagues (2011) considered self-report measures as well

as teacher- and parent-reports on self-control combined into one construct, including items reflecting acting without thinking or considering consequences. These studies consistently confirm that poor self-control results in an early onset and frequent use of cannabis, for self-report as well as teacher reports. One study, using teacher-reports, did not find a significant relationship between self-control and cannabis use. However, this was most likely due to the fact that the self-control scale was combined with two other scales (i.e. cooperation and assertion) into one construct (Griffith-Lendering et al., 2011). Besides self-control, effortful control also is an important construct of self-regulation (Clark, Donnellan, Robins, & Conger, 2015; Creemers et al., 2010; Peeters et al., 2017). Peeters and colleagues (2017) found that low self-reported effortful control at age 11 predicted cannabis use at age 16. Creemers and colleagues (2010) used parent-reports on effortful control. They found that high effortful control resulted in less lifetime cannabis use and less frequent use, because adolescents with high levels of effortful control were less likely to affiliate with cannabis-using peers.

Summarized, self-control and effortful control both influence adolescents' cannabis use. However, the existing literature lacks an empirical study addressing both these concepts of self-regulation in one design. The current longitudinal study offers a complete perspective on self-regulation and cannabis use. New insights are provided by assessing the unique effects of two constructs of self-regulation, measured by different informants, on adolescents' cannabis use.

Affection and cannabis use

Affection refers to liking, respecting, feeling close and getting along with others (Thaxton & Agnew, 2004). Affective ties are important in providing support and a sense of belonging during adolescence (Han, Kim, & Lee, 2016). According to Bowlby's Attachment Theory (Bowlby, May, & Solomon, 1989), emotional connections with key individuals form a secure base for psychological and social development, providing adolescents with the opportunity to explore the world in a secure way. The Attachment Theory applies to risk-behaviour such as delinquency and substance use, including cannabis use (Parker & Benson, 2004). The relationship between affective ties and delinquent behaviour is further explained by the Social Control Theory (Hirschi, 1969), indicating that delinquent behaviour is an outcome of weak social bonds. Close ties to important attachment figures reduce the risk of deviating from the social norms and values, because high quality bonds with society increase the costs of engaging in risk behaviour such as substance use. Key attachment figures in the social environment of adolescents are the parents, but also teachers and classmates, considering adolescents spend more time at school than in any other context (Roeser, Eccles,

& Sameroff, 2000). Therefore, the current study focuses on affective ties with parents, teachers and classmates.

Previous longitudinal studies indicate that parental affection is important in protecting adolescents from engaging in substance use (Dornbusch, Erickson, Laird, & Wong, 2001; Han et al., 2016). Han and colleagues (2016) found that strong parent-adolescent attachment, including affectionate interactions, results in a later age of onset of substance use. A study by Dornbusch and colleagues (2001) focussed specifically on cannabis use, and found that parental affection reduced the frequency of adolescents' cannabis use and delayed the onset.

Besides family context, school is an important learning environment where health behaviour is influenced (Bond et al., 2007). Longitudinal studies consistently indicate that maintaining strong affective ties with teachers protects adolescents from engaging in cannabis use (Black, Grenard, Sussman, & Rohrbach, 2010; Bond et al., 2007; McNeely & Falci, 2004). School attachment is not only defined by affective ties between teachers and students, the extent to which adolescents feel connected to their classmates is an important indicator as well (Dornbusch et al., 2001). Affective ties with peers within school are a protective factor against cannabis use (Bond et al., 2007; Forster, Grigsby, Bunyan, Unger, & Valente, 2015). Forster and colleagues (2015) indicated with a cross-sectional study that adolescents who perceive classmates as important sources for friendships and support were less likely to use cannabis. In conclusion, strong affective ties with classmates and teachers create a sense of belonging and a feeling of connectedness to school, protecting adolescents from frequent cannabis use.

Self-regulation, cannabis use and the moderating effect of affective ties

Behaviour is usually shaped by genetic as well as environmental influences. Moreover, interaction between genes and environment can influence behaviour. Genotype by environment interaction, or person-environment interaction, indicates that the effect of a genetic disposition can be influenced depending on environmental conditions. A genetic predisposition for a specific behaviour may be enhanced by the presence of an environmental condition (Brendgen, 2012). Individual differences in self-regulation capacity are partly explained by genetic differences (Kochanska et al., 2009; Moffitt, Caspi, & Rutter, 2005). The effect of high levels of self-regulation may therefore be enhanced by the presence of a positive environment such as secure attachment relationships to important individuals in the social environment of adolescents.

This theory is supported by results of longitudinal studies on affective ties within the school environment. Although previous research mostly focussed on risks posed by low self-

regulation, it is expected that these outcomes apply to high self-regulation as well. A longitudinal study by Loukas, Roalson and Herrera (2010) showed that school connectedness, a sense of belonging to school and closeness to people at school, protected adolescent girls low in effortful control from externalizing problem behaviour. A longitudinal study by Forster and colleagues (2015), addressing the effect of friendships within school, found significant results for both boys and girls. Adolescents with low levels of self-control who perceived classmates as important sources for friendships and support were less likely to use cannabis. The effect of parental affection has not been investigated yet, although a protective effect for another parenting factor, parental monitoring, on substance use for adolescents low on effortful control was recently found (Clark et al., 2015). It is plausible that other parental factors such as affection may influence the relationship between self-regulation and cannabis use as well.

Summarized, it seems that affective ties can affect the relationship between self-regulation and cannabis use. Previous research confirmed the protecting effect of environmental influences for adolescents with low levels of self-regulation. According to the person-environment interaction, a positive environment can enhance a genetic predisposition as well. The current study contributes to former research by addressing the enhancing effect of affective ties with parents, teachers and classmates for adolescents with high levels of self-regulation on cannabis use.

Current study

According to theory and previous research, adolescents with high levels of self-regulation are less vulnerable for using cannabis, and environmental factors can possibly enhance the effects of high self-regulation. A study is needed to investigate the enhancing effect of affective ties with key individuals and to provide a complete perspective on self-regulation and its two different constructs. Therefore, the current study addresses the question whether there is a relationship between self-regulation and adolescents' cannabis use, and whether this relationship is moderated by affection to parents, teachers and classmates. A complete perspective on cannabis use is achieved by measuring lifetime use, age at onset and frequency of use. This longitudinal study investigates if (1) self-regulation (i.e. self-control and effortful control) influences adolescents' cannabis use, if (2) affection to parents, teachers and classmates influences adolescents' cannabis use and (3) whether these affective ties moderate the relationship between self-regulation and adolescents' cannabis use. The expectations based on theory and former research are reflected in the following hypotheses (see Figure 1): (1) high levels of self-regulation lead to less cannabis use, (2) high affection to

parents, teachers and classmates lead to less cannabis use and (3) affection to parents, teachers and classmates has an enhancing effect on the relationship between high self-regulation and cannabis use.

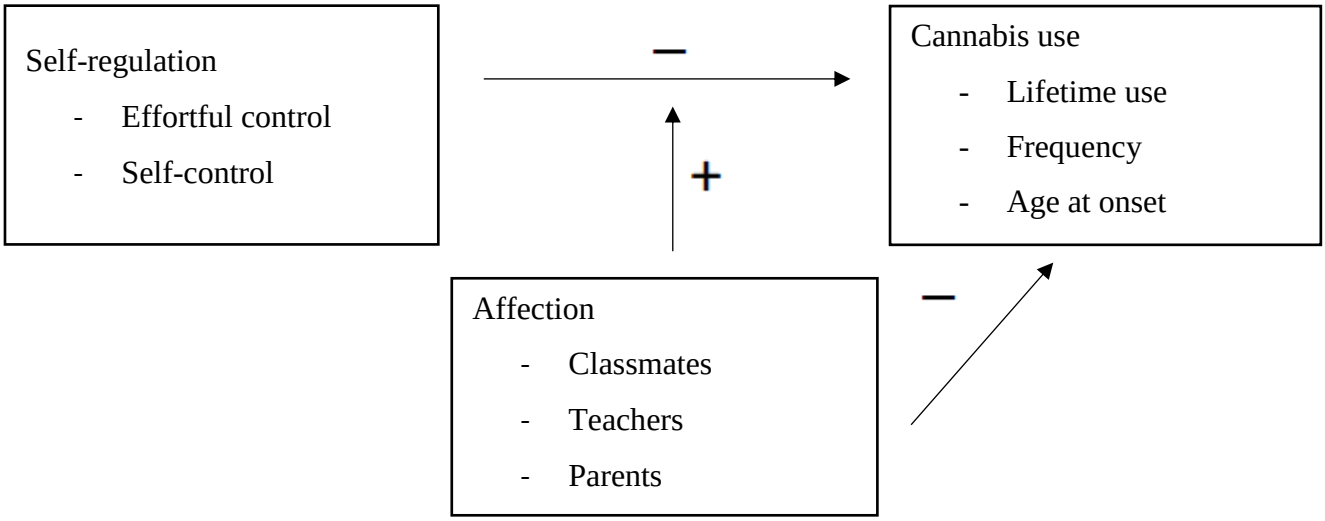

Figure 1. Research model.

Method

Procedure and sample

The current study used data from the Tracking Adolescents' Individual Lives Survey (TRAILS). TRAILS addresses the transition from early adolescence into adulthood, and focusses on internalizing and externalizing problems and a broad range of determinants measured by adolescents themselves, peers, parents and teachers (Huisman et al., 2008). The TRAILS study was approved by the Central Dutch Medical Ethics Committee (Van Oort, Greaves-Lord, Verhulst, Ormel, & Huizing, 2009). Data were collected in five municipalities in the north of the Netherlands. The first two municipalities had to provide the name, date of birth, gender and address of everyone born between 1 October 1989 and 30 September 1990. The last three municipalities provided the same information for all inhabitants born between 1 October 1990 and 30 September 1991. First, 135 primary schools, involving 3483 children, were approached by a letter with information about the goals, design and procedures of the study. Of these schools, 122 schools involving 3145 children agreed to participate (response rate = 90.4% schools, 90.3% adolescents). School participation was a condition for parents and children to be approached. Parents from eligible children were informed through information brochures and invited by telephone to participate in the study. Parents and children themselves had to provide active informed consent, which was repeated at the start of

each new measurement wave (Van Oort et al., 2009). Of the 3145 remaining children, 210 children were excluded because they were not able to participate due to serious health problems or language problems of the parents. This resulted in 2935 eligible children and their parents who were invited to enter the study (response rate = 84.3%). After recruitment efforts through telephone, reminder letters and home visits, 2230 children were included at the first wave (response rate = 76%). Adolescents and teachers filled out questionnaires at school under supervision of TRAILS assistants. Parents were interviewed and filled out questionnaires at their home (Huisman et al., 2008).

Data used in the current study are derived from the first wave (T1, March 2001 – July 2002) and the third wave (T3, September 2005 – August 2007). At T3, 1816 adolescents participated of whom 204 did not answer the questions regarding cannabis use (i.e. lifetime use, age at onset and frequency). It were approximately the same participants who did not respond on all three questions. Therefore, it was decided to exclude these participants from the current study. This resulted in 1612 participating adolescents (72,3% of the initial sample) from which 52.8% girls, and 89.1% with a Dutch ethnicity. The mean age at T1 was 10.57 (SD=.638) and the mean age at T3 was 15.73 (SD=.737). 54.3% was involved in low education (special education and VMBO), 38.6% in high education (HAVO, HAVO/VWO and VWO) and 7.1% in primary education. For the current study, primary education and low education were combined into one category.

An attrition analysis (independent samples t-test) was conducted to detect differences between the initial sample at T1 and the participants included in the current study. Significant differences were found for the control variables sex, ethnicity and education. The responders (M=.47, SD=.499) existed of more girls than the non-responders (M=.55, SD=.498, t(2228)=3.101, p<.01). The responders (M=.11, SD=.311) existed of more participants with a Dutch ethnicity than the non-responders (M=.21, SD=.405, t(2227)=6.050, p<.001). The responders (M=.39, SD=.487) existed of more high educated adolescents than the non-responders (M=.20, SD=.397, t(2228)=-8.661, p<.001). Furthermore, differences were found for the self-regulation variables. The responders (M=2.37, SD=.454) scored higher on teacher-reported self-control than the non-responders (M=2.20, SD=.467, t(1926)=-6.848, p<.001). The responders (M=2.32, SD=.333) scored higher on parent-reported self-control than the non-responders (M=2.24, SD=.346, t(2046)=-4.396, p<.001). The responders (M=3.25, SD=.685) scored higher on parent-reported effortful control than the non-responders (M=3.14, SD=.673, t(1983)=-3.087, p<.01). No differences were found for affection to parents, teachers and classmates.

Measures

Self-regulation: self-regulation was measured at T1 by questions on self-control and effortful control. *Self-control* was measured by *teacher-report* and *parent-report*, with a subscale of The Social Skills Rating System (Gresham & Elliot, 1990). Teacher-report of self-control consisted of 10 items (α=.91)[1]. The self-control subscale included questions on compromising and behavior in conflict situations, such as 'This students can handle criticism well' or 'This student responds appropriately to teasing by peers'. Parent-report of self-control consisted of 10 items as well (α=.80), and addressed similar questions such as 'Can keep the peace in conflict situations with you' or 'Talks with an appropriate voice volume at home'. Questions were rated by teachers and parents on a 3-point scale: '1=never, 2=sometimes and 3=very often'. Furthermore, *effortful control* was measured by *parent-report* and *self-report*. A subscale of the Early Adolescent Temperament Questionnaire was used (Ellis, 2002; Hartman, 2000; Muris & Meesters, 2009; Putnam, Ellis & Rothbart, 2001). Self-report consisted of 13 items (α=.69). Among other questions, adolescents were asked questions such as 'I can easily keep a secret' and 'I postpone things that I have to do until the last moment'. The parent-report scale consists of 11 items (α=.86), addressing similar questions. Items were rated on a 5-point scale, varying from '1=almost never true to 5=almost always true'.

Affection: affection was assessed at T1, by *self-report* on attachment to *mother* (α=.78), *father* (α=.84), *teacher* (α=0.78) and *classmates* (α=.84), all consisting of 4 items. The scales were based on Social Production Function Theory (Lindenberg, 1996; Ormel, Lindenberg, Steverink & Vonkorff, 1997). Attachment to parents was measured by questions including 'I can really trust my mother/father' and 'My mother/father considers my feelings'. The variables for mother and father had a correlation of .657 (p<.001) and were combined into one variable (α=.76)[2], similar to the study of Veenstra, Lindenberg, Tinga and Ormel (2010), because the current study does not distinguish between mother and father. Attachment to teacher and classmates was measured by similar items. All questions were rated on a 5-point scale ranging from '1=never to 5=always'.

Cannabis use: cannabis use was measured at T3, by *self-report*. Three questions were used, to achieve a comprehensive perspective on adolescents' cannabis using behavior. *Lifetime use* was assessed by two answering possibilities: '0=not once and 1=once or more often'. *Frequency of cannabis use the past 12 months* could be answered with '0=0-10,

[1] Cronbach's alfa based on TRAILS codebook and therefore no specific significance for the current study.
[2] Cronbach's alfa based on Veenstra et al. (2010).

11=11-19, 12=20-39 and 13=40 or more'. Participants were also asked about their *age at onset*. Answering categories were '0=never, 1=9 years old or younger' and ranging from '2=10 years old to 8=16 years old'. For the current study, '0=never' was replaced for '9=never', to create a logical sequence. Important to notice is that for lifetime use and frequency, a higher score is a risk-factor, while for age at onset a lower score signifies a risk-factor.

Control variables: based on research about cannabis use among Dutch adolescents, *age*, *sex*, *level of education* and *ethnicity* were included as control variables (Monshouwer et al., 2008). It was expected that older adolescents used cannabis more, and that more boys than girls used cannabis (reference category = girls). Ethnicity was divided in 'Dutch' and 'non-Dutch' (reference category = non-Dutch). It was expected that participants with a Dutch ethnicity used cannabis more. Educational level was divided in low (primary education, special education and all VMBO levels) and high education (HAVO, HAVO/VWO, VWO; reference category = low education). It was expected that low educated participants used more cannabis. Besides, drug use at T1 was added as a control variable to account for the change in use over time. This item measured general drug use including cannabis, not exclusively cannabis use. Cannabis use at T1 was not specifically measured by TRAILS.

Data-analysis

The dataset was checked for outliers by using the Mahalanobis Distance for independent variables and through standardized residuals for dependent variables. It was decided not to delete the outliers from the dataset, because the dataset is rather large so these values will not distort the analysis significantly, and because those particular cases make it interesting to detect which underlying processes are at work here. A point-biserial correlation analysis was conducted for lifetime use, sex, ethnicity and level of education. For the remaining variables, a Pearson correlation analysis was performed. If control variables did not significantly correlate with cannabis use, they were excluded from the study. The independent variables were described by analysing the mean and standard deviation. Cannabis use was described by analysing frequencies of lifetime use, age at onset and frequency of use.

Logistic regression analyses and linear regression analyses were performed to check the first two hypotheses (i.e. 1: negative relationship between self-regulation and cannabis use and 2: between affection and cannabis use). A logistic regression analysis was used to test for lifetime cannabis use, a linear regression analysis to test for frequency and age at onset. First, the assumptions for linear regression were checked (i.e. normal distribution, linearity, outliers, multicollinearity and homoscedasticity). The assumption of normal distribution was violated

for both frequency and age at onset. However, when using a large sample a normal distribution may be assumed (Field, 2013). Logistic regression analyses and linear regression analyses consisted of a first step with the control variables and a second step including the independent variables. In the first step, drug use at T1 was included to test for longitudinal effects. The second step will be described in the results section, because this step contains the important information about the whole model. For the third hypothesis (i.e. moderating effect of affection on the relationship between self-regulation and cannabis use), centered variables for all the independent variables were created. Twelve interaction variables were created by multiplying each centered self-regulation variable with each centered affection variable. For each interaction variable, a linear regression analysis (outcome age at onset and frequency) or logistic regression analysis (outcome lifetime use) was performed separately, resulting in 36 analyses. The first step contained the control variables and drug use at T1, the second step the two centered variables and in the third step the interaction variable was added.

Results

Descriptive statistics

Most adolescents scored low on all variables measuring cannabis use. Drug use at T1 was very low, 98.1% of the sample had never used any drugs. At T3, 69.4% never used cannabis in their life. For age at onset, 2.1% started using cannabis when younger than 12, 13 (5%), 14 (6.8%), 15 (11.3%) or 16 (4.8%). For frequency the past 12 months, 24.5% used cannabis, of whom 4.3% once and 2.9% twice. This percentage decreased until a frequency of 10 times (1.3%), 11-19 times (2.3%), 20-39 times (1.4%) and 40 times or more (3.7%). The means, standard deviations and correlations between dependent, independent and control variables can be found in Table 1. A high correlation between the dependent variables was expected, given that they all measure an aspect of cannabis use and therefore largely overlap.

Significant differences were found between boys and girls. Boys (M=2.02, SD=4.14) scored significantly higher on frequency of cannabis use than girls (M=1.14, SD=2.81, t(1610)=-5.06, p<.001). Furthermore, more adolescents in low education (M=.34, SD=.47) ever used cannabis compared to those in high education (M=.25, SD=.43, t(1610)=3.857, p<.001). Adolescents in low education (M=8.11, SD=1.449) started using cannabis earlier than those in high education (M=8.36, SD=1.26, t(1610)=-3.431, p<.01). Adolescents in low education (M=1.73, SD=3.70) used cannabis more frequently than those in high education (M=1.28, SD=3.21, t(1610)=2.479, p<.05). No significant differences were found for ethnicity. Because no significant correlations were found between ethnicity and other variables, ethnicity was removed as a control variable.

Table 1

Pearson and Point Biserial Correlation Matrix Dependent, Independent and Control Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Lifetime use	-														
2. Age at onset	-.862***	-													
3. Frequency	.665***	-.640***	-												
4. SC teacher[a]	-.116***	.095***	-.077**	-											
5. SC parent	-.043	.027	-.016	.287***	-										
6. EC self[b]	-.108***	.100***	-.107***	.155***	.189***	-									
7. EC parent	-.098***	.105***	-.103***	.280***	.440***	.405***	-								
8. AF teacher[c]	-.128***	.135***	-.083**	.100***	.080**	.199***	.075**	-							
9. AF classmates	-.033	.027	-.018	.087**	.100***	.198***	.081**	.400***	-						
10. AF parents	-.064**	.063*	-.048	.044	.158***	.226***	.112***	.409***	.377***	-					
11. Drug use T1	.095***	-.095***	.086**	-.079**	-.032	-.078**	-.051*	-.119***	-.111***	-.163***	-				
12. Ethnicity[d]	.019	-.023	-.044	.020	-.022	.009	.011	.023	.046	.003	-.011	-			
13. Education[e]	-.096***	.085**	-.062*	.303***	.164***	.180***	.361***	-.016	-.038	.044	-.039	-.043	-		
14. Sex[f]	.026	-.032	.125***	-.234***	-.116***	-.098***	-.189***	-.072**	-.107***	-.060*	.077**	-.018	-.022	-	
15. Age T1	.082**	-.019	.047	-.019	.059*	-.002	.080**	-.033	-.044	-.030	.030	.043	.033	.003	-
M[g]	0.31	8.21	1.56	2.36	2.32	3.59	3.26	3.84	3.47	4.31	0.02	0.11	0.39	0.47	10.57
SD[h]	0.46	1.38	3.52	0.45	0.33	0.54	0.69	0.76	0.80	0.64	0.19	0.31	0.49	0.50	0.64

Note. Point-biserial for lifetime use, sex, ethnicity and education, Pearson for remaining variables. [a]SC = self-control. [b]EC = effortful control. [c]AF = affection. [d] reference = non dutch. [e]reference = low education. [f]reference = girls. [g]M = mean [h]SD = standard deviation.
*p<.05, **p<.01, ***p<.001

Self-regulation and affection predicting cannabis use

A logistic regression analysis was conducted to test the relationship between the independent variables (i.e. self-reported and parent-reported effortful control, parent-reported and teacher-reported self-control and affection to parents, teacher and classmates) and lifetime cannabis use (see Table 2). A significant relation between teacher reported self-control and lifetime cannabis use was found. A significant relation was found between self-reported effortful control and lifetime cannabis use as well. These results indicate that teacher-reported self-control and self-reported effortful control are protective factors against lifetime cannabis use. High levels lead to a lower likelihood of lifetime cannabis use compared to low levels of self-control and effortful control. Furthermore, a significant relation was found between affection to teachers and lifetime cannabis use, indicating that stronger affective ties with teachers result in a lower likelihood of lifetime cannabis use compared to weak affective ties. The control variables drug use at T1 and age at T1 were significant, indicating an increased risk for lifetime cannabis use. The predictors explained 4.8% of the variance of lifetime cannabis use (R^2=.048).

Table 2

Summary of Logistic Regression Analysis for Self-Regulation and Affection Predicting Lifetime Cannabis Use

		Lifetime Cannabis Use	
		95% CI for Odds Ratio	
Variable	*OR*	*Lower*	*Upper*
AgeT1	1.237*	1.008	1.519
Sex[a]	.905	.691	1.185
Education[b]	.753	.561	1.010
Drug use T1	3.454*	1.172	10.183
SC teacher[c]	.671*	.489	.920
SC parents	.954	.614	1.484
EC self[d]	.735*	.562	.961
EC parents	.910	.717	1.154
AF classmates[e]	1.134	.945	1.361
AF teacher	.715**	.588	.868
AF parents	1.102	.875	1.387

Note. n = 1206. R^2=.048 (Cox & Snell).
[a]reference category = girls. [b]reference category = low education. [c]SC = self-control. [d]EC = effortful control. [e]AF = affection.
*p<.05. **p<.01. ***p<.001.

A linear regression analysis was conducted to test the relationship between the independent variables (i.e. self-reported and parent-reported effortful control, parent-reported and teacher-reported self-control and affection to parents, teacher and classmates) and age at onset (see Table 3). A significant effect was found for teacher-reported self-control, indicating that high levels of self-control lead to a later start of cannabis use. Furthermore, affection to teacher was significantly related to adolescents' age at onset. High affection to teacher lead to a later start of cannabis use. No significant results for the control variables were found. The predictors explained 3.5% of the variance (R^2=.035, F(11, 1194)=3.880, p<.001).

Finally, a linear regression analysis was performed to test the relationship between the independent variables (i.e. self-reported and parent-reported effortful control, parent-reported and teacher-reported self-control and affection to parents, teacher and classmates) and frequency of cannabis use during the past 12 months (see Table 3). Self-reported effortful control was significantly related to frequency of us. High levels of effortful control lead to less frequent cannabis use. No significant relationships were found between frequency of use and affection to teacher, classmates or parents. Sex was a significant control variable, indicating an increased risk for frequent cannabis use for boys compared to girls. The predictors explained 2.9% of the variance (R^2=.029, F(11, 1194)=3.269, p<.001).

Table 3

Summary of Linear Regression Analysis for Self-Regulation and Affection Predicting Age at Onset and Frequency

	Cannabis Use					
	Age at onset			Frequency 12 months		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Age T1	.018	.062	.009	.072	.149	.014
Sex[a]	.036	.080	.013	.452	.193	.070*
Education[b]	.136	.086	.050	-.157	.208	-.024
Drug use T1	-.402	.225	-.052	.476	.542	.026
SC teacher[c]	.201	.096	.067*	-.392	.231	-.054
SC parents	-.072	.133	-.018	.167	.320	.017
EC self[d]	.143	.079	.058	-.426	.191	-.072*
EC parents	.080	.071	.041	-.232	.171	-.049
AF classmates[e]	-.076	.054	-.045	.154	.131	.038
AF teacher	.200	.060	.111**	-.215	.144	-.049
AF parents	-.046	.069	-.022	.134	.167	.026

Note. n = 1205 (age at onset and frequency). R^2=.035 (age at onset). R^2=.029 (frequency).
[a]reference category = girls. [b]reference category = low education. [c]SC = self-control. [d]EC = effortful control. [e]AF = affection
*p<.05. **p<.01. ***p<.001.

Moderating effect of affection on the relationship between self-regulation and cannabis use

No significant interaction effects were found for lifetime cannabis use. Besides, no significant interaction effects were found for age at onset. One significant interaction effect was found for frequency of cannabis use. Affection to parents moderated the relationship between parent-reported self-control and frequency of cannabis use. For adolescents with low levels of parent-reported self-control, affection to parents did not show effects. Affection to parents was significant for adolescents with high levels of parent-reported self-control. High affection to parents resulted in less frequent cannabis use for adolescents high on parent-

reported self-control, while low affection to parents resulted in more frequent cannabis use for adolescents high on parent-reported self-control (see Figure 2). The predictors explained 2.8% of the variance (R^2=.028, F(7, 1492)=6.117, p<.001).The results of all interaction analyses can be found in Appendix 1.

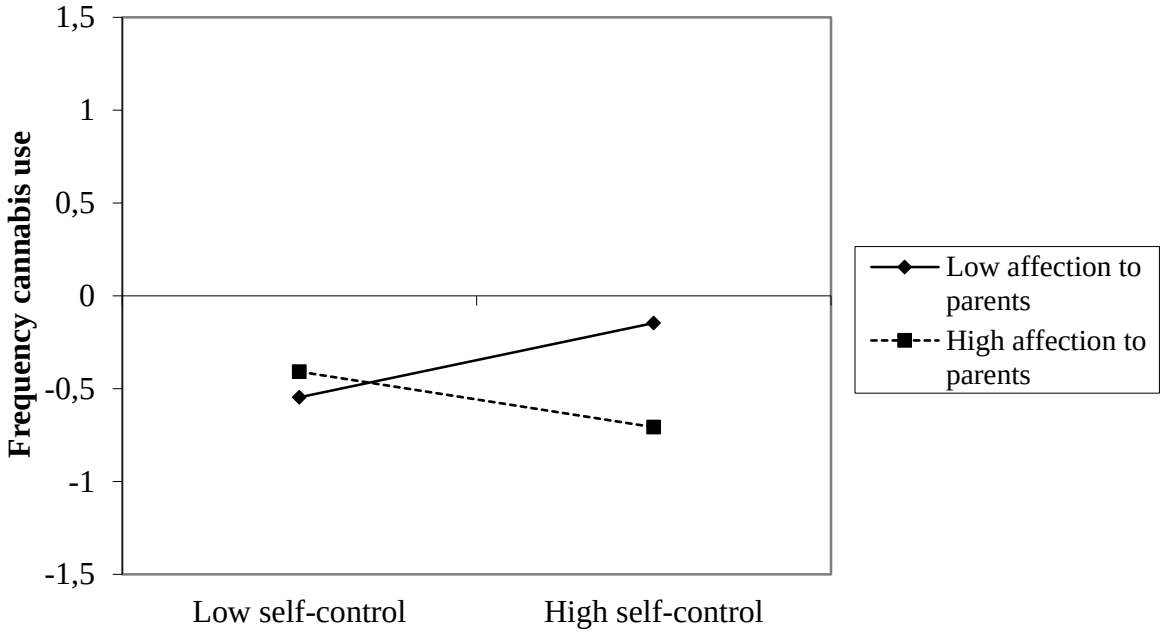

Figure 2. Interaction effect of parent-reported self-control and affection to parents on frequency of cannabis use (n = 1500).[3]

Discussion

The aim of the current study was to test the effect of self-regulation (i.e. effortful control and self-control) on adolescents' cannabis use (i.e. lifetime use, age at onset and frequency). Furthermore, the moderating effect of affection (i.e. to parents, classmates and teachers) on the relationship between self-regulation and cannabis use was tested. High levels of teacher-reported self-control were associated with less lifetime cannabis use and a delayed onset. High levels of self-reported effortful control resulted in less lifetime cannabis use and less frequent use. Parent-reports did not show any effects. High affection to teachers was associated with less lifetime cannabis use and a delayed onset. For affection to parents and classmates, no effects were found. In general, no interaction effects were found except for affection to parents moderating the relationship between parent-reported self-control and frequency of use.

[3] Y-axis = intercept. X-axis = parent-reported self-control.

According to the first hypothesis, high self-regulation leads to less cannabis use. No relationships were found between parent-reported self-control and effortful control and cannabis use, contradicting previous research. This contradiction may be explained because previous research did not analyse parent-reports separately, but combined self-reports, teacher-reports and parent-reports into one construct (King et al., 2015). Results for teacher-reported self-control and self-reported effortful control are in line with the hypothesis, confirming The General Theory of Crime (Gottfredson & Hirschi, 1990). According to this theory, self-regulation influences the ability to control motivation to engage in deviant behaviour such as using cannabis. Significant results were found for self-reports, important sources of information in studies about personality characteristics because these internal processes might be easiest to report by participants themselves (Muris, Meesters, & Blijlevens, 2007). Parent-reports did not show any significant results, while teacher-reports on self-control did. A possible explanation is that parents report on self-regulation as seen in the family context, while teachers report about self-regulation as being expressed in the school context. Questions for teachers were focused on behaviour shown in interaction with peers, while parents answered questions about behaviour shown in interaction with family members. Self-regulation in the school context might be more important in predicting cannabis use, because adolescents' cannabis using behaviour is significantly influenced by contact with peers (Fergusson, Swain-Campbell, & Horwood, 2002). Therefore, teachers might have better insight in adolescents' behaviour predicting cannabis use.

The current study showed that both self-control and effortful control influence adolescents' cannabis use. A correlation of .440 between parent-reported effortful-control and self-control was found, indicating that self-control and effortful control are certainly different constructs. However, teachers and adolescents reported about different constructs, what makes it difficult to decide if one construct of self-regulation has a stronger influence on cannabis use. Therefore, future research should use the same informants for both constructs. Furthermore, neurological tests measuring self-regulation merit further investigation. This aspect of self-regulation was not involved in the current study although these internal processes make an important contribution to the construct of self-regulation (Peeters et al., 2017).

According to the second hypothesis, high levels of affection to parents, teachers and classmates lead to less cannabis use. No effects were found for affection to parents and classmates, but high affection to teachers is related to less lifetime cannabis use and a delayed onset. The results for teacher affection confirm the Social Control Theory (Hirschi, 1969),

stating that attachment to conventional others reduces the risk of deviating from social norms. However, no effects for affection to parents were found. Analyses were also conducted separately for affection to parents, but again no significant effects were found. This contradiction with previous studies may be explained because other research examined a broad definition of parental attachment, and affection only accounted for a small part of these studies. Furthermore, natural mentoring relationships with teachers may be more important for preventing cannabis use, because affective ties with teachers lead to school connectedness. School connectedness leads to less association with delinquent peers and less participation in delinquent activities such as using cannabis (Black et al., 2010; McNeely & Falci, 2004). However, affection to classmates was not significant in the current study. A possible explanation is that teachers are always conventional, while classmates can be conventional or deviant. Affection to conventional classmates may be protective against cannabis, but strong affective ties with deviant classmates can be a risk-factor. Friendships with deviant peers increase the chance of using cannabis (Fergusson et al., 2002; Prinstein, Boergers, & Spiriti, 2001). Future research needs to distinguish between influences from deviant versus conventional peers on adolescents' cannabis use.

For the third hypothesis, an enhancing effect of affection to parents, teachers and classmates was expected on the relationship between high self-regulation and cannabis use. One significant interaction effect was found. Affection to parents enhances the effect of high parent-reported self-control on frequency of cannabis use. However, only one out of 36 interactions was significant, and therefore the hypothesis cannot be confirmed. These results are not in line with previous research and the person-environment interaction (Brendgen, 2012), indicating that a genetic predisposition can be enhanced by environmental factors. A possible explanation for this contradiction is that self-regulation is not only formed by genes. Self-regulation is influenced by other factors as well, such as the social context (Zimmerman, 2000). Furthermore, affection only may not be an adequate indicator of a secure attachment relationship. Attachment is constructed of multiple variables, including affection (Bowlby et al., 1989). Future research has to include other aspects of attachment to parents, teachers and classmates as well, such as support, companionship and intimacy (Kostelecky, 2005). Moreover, a distinction between conventional and deviant classmates is needed, because it is possible that attachment to conventional classmates does have a protective function.

The current study contains some strengths. Different constructs of self-regulation are used. Because both self-control and effortful control are analysed, the current study makes it possible to reveal detailed information on self-regulating processes in adolescents.

Furthermore, multiple informants on self-regulation are considered. The use of self-report as well as parent- and teacher-reports makes it possible to examine self-regulation skills in different contexts, such as the school or family context. This results in an in-depth perspective on the concept of self-regulation and detailed information on the relationship with adolescents' cannabis use. Future research can improve this design by using the same informants for self-control and effortful control to enable comparing the influences of both constructs. The inclusion of different sources of affection also contributes to the strength of the current study. By considering affection to parents, classmates and teachers, influences of different key individuals are distinguished. Furthermore, besides lifetime cannabis use also frequency of use and age at onset were measured. This allows to reveal specific influences of affection and self-regulation on cannabis use.

The current study contains some limitations as well. First, no specific information on cannabis use was measured at the first wave. Only general drug use was included in the study, limiting the possibility to observe change in cannabis use during adolescence. However, drug use at age 10-12 was very low, hence this limitation did not bias the results. Second, attrition analyses showed significant differences between the initial sample and participants included in the current study. The current study consisted of more girls, higher educated participants and participants had higher levels of self-control and effortful control. This may have slightly distorted the results, because these characteristics are related to less cannabis use. Third, linear regression analyses were conducted to test the relationship between self-regulation, affection and frequency of use and age at onset. The assumption of normal distribution was not met which may distort the results. However, the large sample decreases the possibility of bias (Field, 2013). Future research might consider categorizing the outcome variables and conduct other analyses where normality does not have to be met. Finally, although significant effect were found, it is important to consider the low explained variance of the tested models. Self-regulation and affection do influence cannabis use, but only account for a small part of the variance of cannabis use. Future research has to consider other factors, such as neurological influences and a comprehensive construct of attachment, as well.

In conclusion, affection did not moderate the relationship between self-regulation and adolescents' cannabis use. However, it would be interesting to gain more knowledge about the social environment as a moderator. Future research needs to investigate this relationship by not only including affection, but by considering a more extensive construct of attachment. The current study showed that self-control and effortful control influence adolescents' cannabis use. Future research could add to the current study by using the same informants for

both self-control and effortful control. More research is needed before conclusions can be drawn about separate influences of self-control and effortful control on cannabis use. However, the current study indicates that high levels of self-regulation relate to less cannabis use. Therefore, a focus on enhancing self-regulation skills in prevention programs may protect adolescents from using cannabis.

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Appendix 1 – Additional tables

Table 4[4]

Summary of Logistic Regression Analysis for Interactions Between Self-Regulation and Affection Predicting Lifetime Cannabis Use

		Lifetime Cannabis Use	
		95% CI for Odds Ratio	
Variable	*OR*	*Lower*	*Upper*
SCteacher*AFparents	1.034	.688	1.555
SCteacher*AFclass	.988	.722	1.353
SCteacher*AFteacher	1.199	.845	1.700
SCparents*AFparents	.651	.399	1.062
SCparents*AFclass	.937	.626	1.402
SCparents*AFteacher	1.077	.703	1.650
ECchild*AFparents	1.043	.744	1.464
ECchild*AFclass	1.065	.827	1.370
ECchild*AFteacher	1.027	.776	1.360
ECparents*AFparents	1.004	.788	1.280
ECparents*AFclass	1,185	.971	1.445
ECparents*AFteacher	1.213	.975	1.508

Note. SC = self-control. EC = effortful control. AF = affection.
*p<.05. **p<.01. ***p<.001.

[4] Each interaction was analysed separately, including control variables. This table summarizes the main effects of each analysis.

Table 5[5]

Summary of Linear Regression Analysis for Interactions Between Self-Regulation and Affection Predicting Age at Onset and Frequency

	Cannabis Use					
	Age at onset			Frequency 12 months		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
SCteacher*AFparents	-.129	.108	-.033	.308	.320	.027
SCteacher*AFclass	-.005	.099	-.001	.122	.246	.014
SCteacher*AFteacher	-.064	.128	-.014	.498	.270	.051
SCparents*AFparents	.198	.158	.033	-.820	.398	-.054*
SCparents*AFclass	.064	.131	.013	-.179	.329	-.014
SCparents*AFteacher	.021	.137	.004	-.232	.347	-.017
ECchild*AFparents	.011	.106	.003	-.209	.263	-.021
ECchild*AFclass	-.011	.078	-.004	-.063	.194	-.008
ECchild*AFteacher	-.059	.087	-.018	.082	.217	.010
ECparents*AFparents	-.015	.078	-.005	-.244	.197	-.033
ECparents*AFclass	-.069	.063	-.029	.175	.158	.029
ECparents*AFteacher	-.124	.068	-.048	.216	.173	.033

Note. SC = self-control. EC = effortful control. AF = affection
*p<.05. **p<.01. ***p<.001.

[5] Each interaction was analysed separately, including control variables. This table summarizes the main effects of each analysis.