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**Predicting lifetime and regular cannabis use during adolescence; the roles of temperament and peer substance use - The TRAILS-study**

Running head: Cannabis use during adolescence

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## **ABSTRACT**

**Aims** The aim of the present study was to determine the mediating role of affiliation with cannabis-using peers in the pathways from various dimensions of temperament to lifetime cannabis use, and to determine if these associations also contributed to the development of regular cannabis use. **Methods** Objectives were studied using data from 1300 participants of the Tracking Adolescents' Individual Lives Survey (TRAILS), a large, general population study of Dutch adolescents. We used parent-reports on the Early Adolescent Temperament Questionnaire to assess the dimensions high-intensity pleasure, shyness, fearfulness, frustration, and effortful control at age 10-12. By means of self-reports, lifetime and regular cannabis use were determined at age 15-18, and proportion of substance-using peers was determined at ages 12-15 and 15-18. Models were adjusted for age, sex, intelligence, and parental cannabis use. **Results** High-intensity pleasure (OR=1.09, 95%CI=1.05-1.13) and effortful control (OR=0.92, 95%CI=0.89-0.96) affected the risk for lifetime cannabis use through their influence on affiliation with cannabis-using peers. Shyness affected this risk independent from peer cannabis use. Only the pathway from effortful control was additionally associated with the development of regular cannabis use (OR=0.93, 95%CI=0.89-0.98). **Conclusions** Peer cannabis use and, to a lesser extent, certain temperamental characteristics affect an adolescents risk of cannabis use, and should be considered in prevention programs. We recommend future research to focus on factors that potentially modify the association between temperament, affiliation with cannabis-using peers and cannabis use.

## **INTRODUCTION**

While cannabis has generally been perceived to be a relatively harmless drug, the growing number of cannabis clients in addiction care [1, 2] indicates that the use of cannabis is not as harmless as was once considered. For adolescent users, it has been estimated that 18 to 20 percent develop a cannabis use disorder within ten years from initiation of use [3, 4]. Particularly adolescents that started using cannabis at an early age, or that use cannabis on a regular or persistent basis, are at risk of developing a cannabis use disorder [4, 5]. Research on the determinants of cannabis use during adolescence can improve our understanding of which factors are related to adolescent cannabis use and to the development of regular patterns of cannabis use.

Longitudinal studies have focused on several risk factors of cannabis use in adolescents and young adults, including intrapersonal factors, for instance temperamental attributes, and interpersonal variables, such as belonging to a deviant and/or substance-using peer group [6, 7]. With regard to the latter, social learning has been one of the proposed mechanisms to explain the association between peer and own substance use: through associations with peers the adolescent acquires certain norms and behaviors that are favorable of or opposed to using drugs [8]. In addition, peers might encourage substance use by making drugs available [9]. When temperament is considered in relation to cannabis use, some studies have demonstrated prospective associations between specific temperament dimensions and cannabis use. For instance, higher levels of sensation seeking have been prospectively related to lifetime cannabis use and extent of cannabis use in middle and late adolescence [10-12]. In addition, indices of negative affect or negative emotionality have been linked to substance use, including cannabis, and to increased

growth in substance use during adolescence [13-16]. In contrast, indicators of attentional control have been found to buffer against initiation and increasing levels of substance use [16, 17]. Interestingly, when temperament is considered next to other risk factors of cannabis use, such as affiliation with deviant peers, direct associations between temperament and cannabis use are less obvious [6]. For instance, Donohew and coworkers found that sensation seeking, in the context of factors related to peer substance use, failed to predict frequency of cannabis use two years later [18]. This finding points in the direction of a mediated pathway from sensation seeking to frequency of cannabis use through affiliation with substance-using peers. Indeed, findings from a longitudinal study by Hampson et al. indicate that affiliation with peers that display general disruptive behavior mediated the effect of sensation seeking on extent of marijuana use [11]. In addition, findings from a study by Wills and Cleary indicate that difficult temperament and poor self-control are related to affiliation with substance-using peers that subsequently predicts initial level and frequency on a composite measure of tobacco, alcohol and cannabis use [19].

In order to extend the findings from previous research, we aimed to determine the mediating role of affiliation with cannabis-using peers in the pathways from various dimensions of temperament to lifetime and regular cannabis use, the latter defined as the use of cannabis on at least four occasions in the past four weeks. Because the use of cannabis is generally considered more deviant than legal substance use in this age group, we focused on affiliation with specifically cannabis-using peers, rather than affiliation with a broader group of deviant and/or licit substance-using peers. Based on findings from previous research we selected indicators of the temperament dimensions sensation seeking, negative affectivity and attentional or effortful control. Within the biologically-oriented temperament model

developed by Rothbart and colleagues [20], the broad dimension surgency, manifested as orientation to and exploration of novelty, is indexed by the temperament dimensions high-intensity pleasure, (low) shyness and (low) fearfulness [21]. High-intensity pleasure is based on the Zuckerman construct of sensation seeking [22, 23]. Within the same framework, frustration is, in adolescents, the main indicator of the broad temperament factor negative affectivity [21]. Effortful control is the sole indicator of the similarly named broad dimension, and is conceptually related to task attentional orientation, that has also previously been linked to adolescent substance use [16, 17]. While we expected risk-enhancing effects of high-intensity pleasure and frustration on affiliation with cannabis-using peers and cannabis use, we expected risk-buffering effects of shyness, fearfulness and effortful control.

## **METHODS**

### ***Sample and participants***

The present study reports data from the first (T1), second (T2) and third (T3) assessments of TRAILS, which ran from 2001 to 2002, 2003 to 2004, and 2005 to 2007, respectively. A detailed description of the sampling procedure and methods is provided in De Winter et al. [24]. Briefly, the TRAILS target sample involved all 10- to 11-year-old children living in five municipalities in the North of the Netherlands, including both urban and rural areas. Seventy-six percent of the target population ( $n=2230$ , mean age = 11.09,  $SD = 0.55$ , 50.8% girls) was enrolled in the study (i.e., both child and parent agreed to participate). Responders and non-responders did not differ with respect to the prevalence of teacher-rated problem behavior and the associations between sociodemographic variables and mental health indicators [24]. At T2, 96.4% of these participants ( $N=2149$ , mean age 13.56 years;  $SD 0.53$ , 51.0%

girls) were re-assessed, including the collection of peer nominations in a subsample of TRAILS participants and their classmates. This subsample consisted of 3312 students (mean age 13.60,  $SD = 0.66$ , 49.4% girls), including 1007 regular TRAILS participants. Peer nominations were assessed in classrooms with at least three regular TRAILS participants. The school classes were almost equally divided among levels of education: low education (60 school classes), middle education (53 school classes), and high education (59 school classes). A detailed description of the assessment of the peer nominations is provided in Dijkstra et al. [25]. T3 was completed with 81.4% of the original number of participants ( $N=1816$ , mean age = 16.27 years,  $SD 0.73$ , 52.3% girls).

To answer the aims of the present study we composed a subgroup based on available data with regard to temperament at T1, affiliation with cannabis-using peers at T3 and cannabis use at T3 ( $N=1300$ ). Participants included in this subgroup were more likely to be female ( $\chi^2 (1 \text{ df}, N = 2230) = 28.45, p < .001$ ), to have a higher socioeconomic status ( $\chi^2 (2 \text{ df}, N = 2230) = 92.11, p < .001$ ), and to have a higher intelligence ( $t=10.58, 2228 \text{ df}, p < .001$ ) when compared to the excluded participants ( $N=930$ ). When compared to participants with available data on T3 cannabis use that were excluded due to missing information on temperament or peer cannabis use ( $N=340$ ), included participants were equally likely to report lifetime ( $\chi^2 (1 \text{ df}, N = 1640) = 0.11, p = .74$ ) and regular cannabis use at T3 ( $\chi^2 (1 \text{ df}, N = 1640) = 2.55, p = .11$ ).

Using data from the peer-nominations collected at T2 we were able to verify that affiliation with substance-using peers preceded cannabis use in a subsample consisting of 697 of the 1300 participants. Included and excluded participants did not differ in terms of T3 lifetime ( $\chi^2 (1 \text{ df}, N = 1300) = 0.29, p = .59$ ) and regular ( $\chi^2 (1 \text{ df}, N$

= 1300) = 0.03,  $p=.85$ ) cannabis use, and affiliation with cannabis-using peers at T3 ( $t=-.08$ , 1298 df,  $p=.94$ ).

## **Measures**

*Cannabis use* was assessed at T3 by self-report questionnaires filled out at school, supervised by TRAILS assistants. Confidentiality of the study was emphasized so that adolescents were reassured that their parents or teachers would not have access to the information they provided. Among other questions, participants were asked to report the frequency of cannabis use ever and in the past four weeks. Answers on these questions were dichotomized in order to achieve a measure of lifetime cannabis use, defined as any cannabis use ever, and regular cannabis use, defined as the use of cannabis on at least four occasions in the past four weeks.

The *proportion of cannabis using peers at T3* was assessed from a self-report questionnaire in which participants were asked to name up to seven friends, and to report for each of these friends in separate questions whether they ever used cigarettes, alcohol, soft drugs and hard drugs. In the Netherlands, the term soft drug usually refers to cannabis. The proportion of cannabis-using peers was acquired by dividing the number of soft drug-using friends by the total number of friends. Data from the peer nominations at T2 did not provide specific information about peer cannabis use. Alternatively, substance use ('who drinks alcohol and/or uses soft drugs on a regular basis?') was assessed for all classmates. In addition, the number of best friends (unlimited) within the class ('which classmates are your best friends?') was assessed. *Proportion of substance-using peers at T2* was acquired by dividing the number of substance-using friends by the total number of friends. To obtain a T3



measure that was comparable to the proportion of substance-using peers at T2, the number of alcohol- and/or soft drug-using friends at T3 was divided by the total number of friends reported at T3.

*Early adolescent temperament* was assessed at T1 by the parent version of the short form of the Early Adolescent Temperament Questionnaire – Revised (EATQ-R) [21]. The Dutch translation of the EATQ-R identifies six temperament dimensions and two behavioral dimensions [26]. For the present study we used the dimensions: 1) high-intensity pleasure, defined as the pleasure derived from activities involving high intensity or novelty (6 items,  $\alpha = 0.77$ ); 2) shyness, referring to behavioral inhibition to novelty and challenge, especially in social situations (4 items,  $\alpha = 0.84$ ); 3) fearfulness, manifested in worrying and unpleasant affect related to the anticipation of distress (5 items,  $\alpha = 0.63$ ); 4) frustration, defined as negative affect related to the interruption of ongoing tasks or goals blocking (5 items,  $\alpha = 0.74$ ), and 5) effortful control, defined as the capacity to voluntarily regulate behavior and attention (11 items,  $\alpha = 0.86$ ).

### *Covariates*

*Parental cannabis use* was assessed at T3. In most cases, mothers completed a questionnaire about their own and their partners' lifetime and past year cannabis use. For both parents, responses were categorized into never, ever (used cannabis but not in the past year), and past year cannabis use. Maternal and paternal scores were summed to achieve a composite score of parental cannabis use.

*Socioeconomic status (SES)* was calculated as the average of income level, educational level, and occupational level of each parent at T1, using the International

Standard Classification for Occupations [27], and was categorized in low, average and high SES.

*Intelligence* was individually assessed at T1 by the Vocabulary and Block Design subtests [28] from the Revised Wechsler Intelligence Scales for Children (WISC-R) [29, 30].

### ***Statistical approach***

Statistical analyses were performed using the Statistical Package of Social Sciences version 15.0 for Windows (SPSS Inc. Chicago, IL) and Mplus 5.1 [31]. All continuous variables were standardized to a mean of 0 and a standard deviation of 1. Means of variables were calculated, and gender differences in means and proportions were analyzed by t-tests and  $\chi^2$ -tests, respectively. Models were initially adjusted for age, sex, intelligence, SES, and parental cannabis use. In order to achieve the most parsimonious models, non-significant covariates were excluded from the models by backward exclusion.

First, we tested the hypothesized associations between temperament, affiliation with cannabis-using peers, and lifetime cannabis use by comparing lifetime cannabis users and abstainers. We tested the predictive power of each of the temperament dimensions by performing separate logistic regressions with lifetime cannabis use as the outcome variable. Based on these crude associations, we included all significant temperament dimensions in the next model, which was specified to assess the independent prediction by the different dimensions of temperament. The final temperament model included only the dimensions that remained significant. Next, we specified a logistic regression model to assess the association between the proportion of cannabis-using peers and lifetime cannabis

use. In order to test mediation, we first specified a direct path model in which lifetime cannabis use was regressed on the temperament dimensions of the final model, in addition to regressing the proportion of cannabis-using peers on these dimensions. This was done to ascertain that direct associations between temperament and both proportion of cannabis-using peers and lifetime cannabis use were present. Subsequently, we specified a full mediation path model by additionally allowing for the direct path from proportion of cannabis-using peers to lifetime cannabis use. To test for an indirect relation from temperament to lifetime cannabis use via proportion of cannabis-using peers, a joint significance test of the indirect paths was used [32-34]. In order to determine if the identified mechanisms also contributed to the development of regular patterns of cannabis use, tests of the significant associations were repeated in a subgroup including regular and less regular cannabis users. Model fit was determined using the comparative fit index (CFI, critical value = 0.95) and the root mean square error of approximation (RMSEA, critical value = 0.08) [35, 36]. In order to determine whether the mediation model was a better representation of the data when compared to an additive model, model fit was compared using the chi-square difference tests for weighted least squares means and variance adjusted (WLSMV) and maximum likelihood means and variance adjusted (MLMV) estimation [31]. To determine the prospective relation between proportion of substance-using peers and lifetime and regular cannabis use, we additionally performed two hierarchical logistic regression models in which lifetime and regular cannabis use at T3 were regressed on the significant covariates in the first step, on proportion of substance-using peers at T3 in the second step, and on proportion of substance-using peers at T2 in the final step. For this final analysis we used the subsample with available data on the peer nominations (N=697).

## RESULTS

### *Descriptive statistics*

At age 15-18, lifetime and regular cannabis use were reported by, respectively, 30.2% and 5.6% of the adolescents. Whereas boys and girls did not differ in the prevalence of lifetime cannabis use, boys were more likely than girls to be regular cannabis users ( $\chi^2$  (1 df, N = 1300) = 27.71,  $p < .001$ ). Means of the unstandardized scores or percentages of the variables used are shown in Table 1.

### *Lifetime cannabis use*

As presented in Table 2, findings from the separate logistic regression analyses indicated that high-intensity pleasure and frustration tended to enhance the risk of cannabis use, whereas effortful control and shyness buffered this risk. Fearfulness was not significantly related to cannabis use. Findings from the multivariate model indicated independent predictive power for high-intensity pleasure, shyness and effortful control. Proportion of cannabis-using peers at T3 was significantly associated with cannabis use. The most parsimonious models included age, intelligence, and parental cannabis use as covariates.

In order to test mediation, we first ascertained the presence of direct associations between the temperament dimensions of the final model and proportion of cannabis-using peers. Whereas high-intensity pleasure ( $\beta = 0.13$ , 95%CI = 0.07-0.19,  $p < 0.001$ ) and effortful control ( $\beta = -0.13$ , 95%CI = -0.18 to -0.07,  $p < 0.001$ ) were prospectively related to proportion of cannabis-using peers, shyness was not ( $\beta = -0.06$ , 95%CI = -0.11-0,  $p = 0.06$ ).

Subsequently, a full mediation model was specified including the paths from each of the three temperament dimensions and proportion of cannabis-using peers to lifetime cannabis use, from high-intensity pleasure and effortful control to proportion of cannabis-using peers, and the indirect paths from high-intensity pleasure and effortful control to lifetime cannabis use through proportion of cannabis-using peers. Findings indicated that proportion of cannabis-using peers mediated the pathways from high-intensity pleasure (OR=1.09, 95%CI=1.05-1.13,  $p<0.001$ ) and effortful control (OR=0.92, 95%CI=0.89-0.96,  $p<0.001$ ) to lifetime cannabis use. The direct paths from high-intensity pleasure (OR=1.08, 95%CI=1.01-1.16,  $p<0.05$ ) and effortful control (OR=0.94, 95%CI=0.88-1.01,  $p=0.09$ ) to frequent cannabis use were attenuated. Whereas the path from effortful control to lifetime cannabis use failed to reach significance, suggesting (largely) full mediation, the association between high-intensity pleasure and cannabis use was partially mediated by proportion of cannabis-using peers. The CFI=0.99 and RMSEA=0.05 indicated a good fit. Chi-square difference testing indicated that the mediation model fitted significantly better than an additive model with the temperament dimensions and proportion of cannabis-using peers as predictors ( $\chi^2(1) = 280.53$ ,  $p<0.001$ ). The full mediation model is depicted in Figure 1.

### ***Regular cannabis use***

When tests of the significant associations were repeated in a subgroup including only lifetime cannabis users ( $n=394$ ), divided in regular and less regular users, crude associations demonstrated that regular cannabis users were characterized by higher levels of effortful control at T1 and by a higher proportion of cannabis-using peers at T3. Regular and less regular users could not be

differentiated by their levels of high-intensity pleasure or shyness (Table 2). Findings from the mediation model, depicted in Figure 2, indicated that effortful control buffered against the development of regular cannabis use through its buffering effect on affiliation with cannabis-using peers (OR=0.93, 95%CI=0.89-0.98,  $p<0.01$ ). The direct path from effortful control to frequent cannabis use did not remain significant (OR=0.89, 95%CI=0.76-1.04,  $p=0.13$ ), indicating (largely) full mediation. In these models, sex was the only significant covariate. The CFI=0.95 and RMSEA=0.07 indicated a sufficient fit. The mediation model fitted significantly better than an additive model with effortful control and proportion of cannabis-using peers as predictors ( $\chi^2(1) = 36.71, p<0.001$ ).

### ***The prospective relation between affiliations with substance-using peers and cannabis use***

Findings from the hierarchical logistic regression model in a subsample of the TRAILS population (N=697) ascertained the prospective relation between affiliation with substance-using peers and lifetime cannabis use. In the final model, adjusted for the covariates age, parental cannabis use, SES, and for proportion of substance-using peers at T3, proportion of substance-using peers at T2 predicted lifetime cannabis use (OR=1.33, 95%CI=1.12-1.58,  $p<0.01$ ). Proportion of substance-using peers did not predict regular cannabis use (OR=1.05, 95%CI=0.78-1.40,  $p=0.76$ ).

## **DISCUSSION**

Using data from a large, longitudinal, general population sample of adolescents, we had the unique opportunity to examine the mediating role of exposure to cannabis-using peers in the pathways from various dimensions of

temperament to lifetime and regular cannabis use. Crude associations indicated that proportion of cannabis-using peers was most strongly associated with lifetime and regular cannabis use. Particularly in adolescence, the association between peer factors and substance use outcomes becomes increasingly powerful [37]. We found, in agreement with prior studies [10, 19, 38, 39], risk-enhancing effects of high-intensity pleasure and risk-buffering effects of shyness and effortful control. While effortful control also appeared to buffer one's risk to progress into regular cannabis use, high-intensity pleasure and shyness were not prospectively related to regular cannabis use. Although previous studies have demonstrated prospective associations between related temperament dimensions, e.g. sensation seeking and behavioural inhibition, and frequency of use in young adolescents [12, 40], we do not know of any studies that investigated their association with specifically regular cannabis use. This combination of findings suggests that characteristics related to sensation seeking and behavioural inhibition contribute to one's risk to initiate and continue the use of cannabis, but that regular users constitute a specific subgroup that is less influenced by these temperamental traits. Contrary to our expectations, fearfulness and frustration were not (independently) associated with lifetime and regular cannabis use. The former might be due to the relatively low reliability of the subscale fearfulness ( $\alpha = 0.63$ ), or to moderation by other risk factors that may influence the presence and direction of the association between fearfulness and cannabis use. More specifically, fearfulness was expected to be associated with a reduced risk of cannabis use because of its buffering influence on impulsive and risk-taking behaviors. However, adolescents with high levels of fearfulness might also be more likely to use cannabis in order to reduce negative affect. Yet, Swaim et al. have suggested that theories that view adolescent drug use as providing negative affect

reduction might be more applicable to later stage substance abuse than to adolescent substance use [41]. This might also explain the absence of a significant relationship between frustration and cannabis use.

Findings from the mediation analyses indicated that temperament affected the risk of lifetime and regular cannabis use mainly by influencing the adolescents' tendency to affiliate with cannabis-using peers. These findings add to prior cross-sectional and longitudinal evidence of associations between related temperament dimensions and lifetime and frequency of cannabis and other substance use [11, 18, 42, 43]. The exception was the temperament dimension shyness. While shyness was expected to buffer the risk of cannabis use by making affiliation with cannabis-using peers less likely, the association between shyness and affiliation with cannabis-using peers failed to reach significance at the  $p < 0.05$  level. Thus, the hypothesized pathway might hold for some individuals, but may be modified by other factors, including exposure to or coping with peer pressure. When allowing for the indirect paths through affiliation with cannabis-using peers, effortful control appeared to be only indirectly related to lifetime and regular cannabis use. This is in line with the primary socialization theory [44], according to which personal characteristics and personality traits affect drug use only indirectly through their effect on association with primary socialization agents, such as peers. However, high-intensity pleasure remained also directly related to lifetime cannabis use. Although this is in line with the cross-sectional findings by Yanovitzky et al., other studies have found only indirect effects between sensation seeking and frequency of cannabis use through affiliation with deviant or sensation-seeking peers [11, 18, 43].

In agreement with findings from previous studies using various measures of substance use [19, 45, 46], our findings provided support for a prospective relation



between affiliation with substance-using peers and lifetime cannabis use. Having relatively more substance-using peers is likely to promote the adoption of attitudes favorable towards drug use and to increase the number of opportunities to use drugs, resulting in a higher likelihood of own substance use. However, affiliation with substance-using peers was not related to regular cannabis use. This might however be explained by our measure of peer substance use, indicated by peer alcohol and cannabis use. We expect that specifically peer cannabis use, rather than the more common use of alcohol, is associated with the development of regular patterns of cannabis use. Own cannabis use might also precede the selection of a substance-using peer group. Although previous studies have yielded inconsistent findings with regard to this latter mechanism, i.e. peer selection [19, 47, 48], findings from recent studies are consistent with this hypothesis [49, 50].

The present study is not without limitations. At T2 we did not assess the proportion of cannabis-using peers. As an alternative, we composed a variable based on information about peer use of 'alcohol or soft drugs' that was collected in a subsample (N=1007). Because the use of this variable placed restrictions on sample size and on the ability to study cannabis-specific associations between peer and own cannabis use, we used this measure only to ascertain a prospective association between proportion of substance-using peers and lifetime and regular cannabis use. As our findings provided support for this assumption with regard to lifetime cannabis use, we felt it was justified to model peer cannabis use at T3 as a mediator in the pathway from temperament at T1 to cannabis use at T3. However, our findings did not support the presence of a prospective association between affiliation with substance-using peers and regular cannabis use. Moreover, given the cross-sectional nature of the information on affiliation with cannabis-using peers and own

cannabis use, the temporal precedence between the variables could not be established. Finally, as is common in large surveys, information about some factors, i.e. cannabis use, affiliation with cannabis-using peers, and parental cannabis use, was obtained using single or several items, rather than more extensive instruments.

### ***Conclusions***

In conclusion, this study showed that effortful control and high-intensity pleasure affected the risk for lifetime cannabis use through their influence on affiliation with cannabis-using peers: whereas adolescents with higher levels of effortful control were less likely to select cannabis-using peers, those with higher levels of high-intensity pleasure affiliated more with cannabis-using peers. Shyness seemed to affect this risk independent from peer cannabis use. Only the pathway from effortful control was additionally associated with the development of regular cannabis use. These findings contribute to the current knowledge about adolescent lifetime and regular cannabis use, which have been associated with an increased risk of developing a cannabis use disorder [3, 4].

### ***Implications for future research and prevention***

Some of our findings lead us to suggest that the impact of temperamental characteristics on affiliation with cannabis-using peers, and on lifetime and regular cannabis use is modified by other risk factors, such as parenting behaviors and coping strategies. In order to further understand the relation between temperament and adolescent cannabis use, and given the potential of modifying factors for improving prevention efforts, we recommend future research to address the interplay between temperament and other risk factors of cannabis use. Given the fact that

temperamental characteristics, with the exception of effortful control, seem to relate differently to lifetime and regular cannabis use, we recommend these studies to focus on specific and potentially hazardous patterns of cannabis use, rather than on cannabis use in general. Our findings also offered some interesting information that provides additional directions for future research. Although cross-sectional in nature, the covariate parental cannabis use was significantly associated with a higher risk of frequent cannabis use and with more affiliation with cannabis-using peers. In order to explore the influence of parental cannabis use on the selection of cannabis-using peers and on the development of frequent cannabis use, we recommend future prospective research in this area.

The results of this study have implications for prevention work. Our findings emphasize the importance of peers in adolescent cannabis use. They therefore indicate that prevention programs should include modules designed to enhance skills to resist social influences to engage in substance use. Prior research has suggested that, at least for programs teaching social competency skills, targeting high risk youths may yield stronger effects than targeting the general population [51]. Findings from the present study suggest that particularly adolescents with high levels of high-intensity pleasure and low levels of effortful control and shyness should be targeted, because these individuals are at increased risk of affiliation with cannabis-using peers and potentially hazardous patterns of cannabis use. As temperament or personality factors are expected to predict substance use by influencing specific motivational processes underlying substance use [52], we also suggest that prevention programs should include cognitive behavioural components aimed at enhancing the development of healthy coping strategies.

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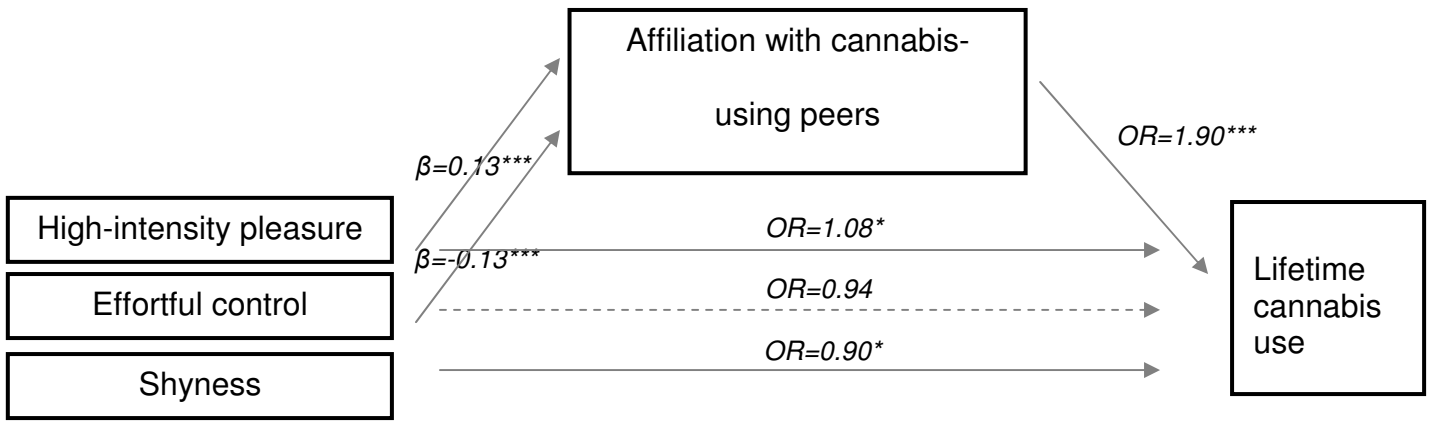


Figure 1. Final mediation model

*The most parsimonious model was adjusted for age, intelligence and parental cannabis use.*

*All continuous variables were standardized to mean zero and standard deviation 1.*

*\*  $p < .05$ , \*\*\*  $p < .001$ , OR = Odds Ratio*



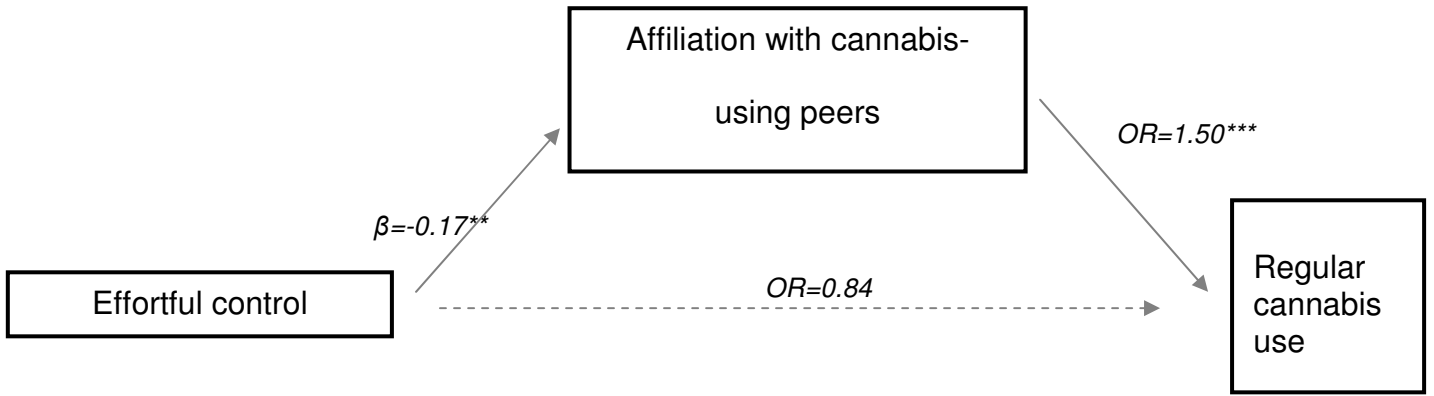


Figure 2. Final mediation model

*The most parsimonious model was adjusted for sex.*

*All continuous variables were standardized to mean zero and standard deviation 1.*

*\*\*  $p < .01$ , \*\*\*  $p < .001$ , OR = Odds Ratio*

Table 1. Descriptive statistics

<b><i>n=1300</i></b>	Boys ( <i>n</i> =579)	Girls ( <i>n</i> =721)	Gender difference		
	Mean (SD)	Mean (SD)	T/ $\chi^2$	<i>df</i>	<i>p</i>
Lifetime cannabis use	30.9%	29.8%	0.18	1	0.67
Regular cannabis use	9.5%	2.5%	27.71	1	<0.001
Proportion of cannabis-using peers T3	0.22 (0.31)	0.16 (0.26)	3.27	1123*	<0.01
High-intensity pleasure	3.44 (0.92)	3.23 (0.90)	4.00	1288	<0.001
Shyness	2.40 (0.86)	2.58 (0.87)	-3.65	1288	<0.001
Fearfulness	2.35 (0.70)	2.47 (0.72)	-3.05	1288	<0.01
Frustration	2.84 (0.68)	2.72 (0.63)	3.32	1288	<0.01
Effortful control	3.11 (0.71)	3.38 (0.65)	-7.09	1288	<0.001
<b><i>n=697</i></b>	Boys ( <i>n</i> =306)	Girls ( <i>n</i> =391)	Gender difference		
Lifetime cannabis use	33%	29.9%	0.76	1	0.38
Regular cannabis use	10.5%	2.3%	20.62	1	<0.001
Proportion of substance-using peers T2	0.11 (0.24)	0.09 (0.21)	1.21	695	0.23
Proportion of substance-using peers T3	0.76 (0.33)	0.75 (0.33)	0.27	695	0.79

\* Degrees of freedom not equal to *n*-1 due to correction for unequal variances.

Table 2. Associations between temperament, proportion of cannabis-using peers at T3 and lifetime and frequent cannabis use at T3.

	Lifetime cannabis users versus abstainers (n=1300)				Regular users versus less regular users (n=394)	
	Crude associations		Multivariate model		Crude associations	
	OR	95% CI	OR	95% CI	OR	95% CI
High-intensity pleasure	1.20***	1.11 – 1.29	1.18***	1.08-1.28	1.04	0.87 – 1.24
Shyness	0.87**	0.81 – 0.94	0.90*	0.83-0.98	0.97	0.81 – 1.14
Fearfulness	0.99	0.91 – 1.06				
Frustration	1.10*	1.02 – 1.18				
Effortful control	0.88**	0.82 – 0.96	0.87**	0.80-0.94	0.83*	0.70 – 0.98
Proportion of cannabis-using peers T3	2.35***	2.14 – 2.58			1.59***	1.38 – 1.84

*Multivariate model refers to a model including all significant temperament dimensions as predictors. The most parsimonious n=1300 models were adjusted for age, intelligence and parental cannabis use, the most parsimonious n=394 models were adjusted for sex.*

*All continuous variables were standardized to mean zero and standard deviation 1.*

*\* p<.05, \*\* p< .01, \*\*\* p< .001, CI= Confidence Interval*