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Dissociation between implicit and explicit expectancies of cannabis use in adolescence

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ABSTRACT

Cannabis is one of the most commonly drugs used by teenagers. Expectancies about its effects play a crucial role in cannabis consumption. Various tools have been used to assess expectancies, mainly self-report questionnaires measuring explicit expectancies, but implicit measures based on experimental tasks have also been developed, measuring implicit expectancies. The aim of this study was to simultaneously assess implicit/explicit expectancies related to cannabis among adolescent users and non-users. 130 teenagers attending school (55 girls) were enrolled (Age: $M=16.40$ years); 43.84% had never used cannabis ("non-users") and 56.16% had used cannabis ("users"). They completed self-report questionnaires evaluating cannabis use, cannabis-related problems, effect expectancies (explicit expectancies), alcohol use, social and trait anxiety, depression, as well as three Implicit Association Tests (IAT) assessing implicit expectancies. Adolescents manifested more implicit affective associations (relaxation, excitation, negative) than neutral ones regarding cannabis. These were not related to explicit expectancies. Cannabis users reported more implicit relaxation expectancies and less negative explicit expectancies than non-users. The frequency of use and related problems were positively associated with the explicit expectancies regarding relaxation and enhancement, and were negatively associated with negative explicit expectancies and negative implicit expectancies. Findings indicate that implicit and explicit expectancies play different roles in cannabis use by adolescents. The implications for experimentation and prevention are discussed.

1. Introduction

Cannabis is one of the most commonly drugs used by teenagers (15–17 years of age) around the world, with a mean lifetime prevalence of 30% among European students (European Monitoring Centre for Drugs and Drug Addiction, 2012) and 35% among American students (National Institute on Drug Abuse, 2014). In the long run, this substance can induce many behavioral (e.g., risk-taking behaviors or motivational impairments), physiological (e.g., respiratory or neurocognitive symptoms), psychological (e.g., anxiety or mood disorders) and social (e.g., work, school or interpersonal disabilities) effects on adolescents and young adults (Patton et al., 2002; Looby and Earleywine, 2007; Zvolensky et al., 2010; Degenhardt et al., 2012; Thames et al., 2014). Moreover, cannabis use in adolescence may increase the risk of addictive behaviors in adulthood, particularly for vulnerable individuals (Hurd et al., 2013).

Adolescence thus constitutes a key period for investigating cannabis use and particularly to explore the early consumption stages. This developmental stage is characterized by a stressful shift from immaturity to maturity, including behavioral and cognitive changes. Teenagers often have difficulties to cope with these transitions, especially environmental and social challenges (Jessor, 1993; Collins, 2001). Compared with adults, they experience more stressors and negative life events (Larson and Asmussen, 1991; Buchanan et al., 1992), and they respond to and interact quite differently with their environment (Spear, 2000). Adolescence is thus a critical period for cannabis use and for initiating a trajectory of consumption in adulthood, and the present research proposes to specifically investigate this relevant developmental stage.

Cannabis use is influenced by a broad range of variables: genetic and environmental factors (Verweij et al., 2010), peer influence (Creemers et al., 2010; Poulin et al., 2011), comorbid substance use such as alcohol or tobacco (Coffey et al., 2000; Pedersen et al., 2001), and psychopathological symptoms such as anxiety or

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depression (Boys et al., 2001; Crippa et al., 2009). Moreover, personal expectancies about the effects of cannabis use may also play a crucial role in cannabis consumption. The most frequently reported reasons for using cannabis are to seek enjoyment, fun, experimentation, social enhancement or relaxation, or to reduce boredom, stress or anxiety (Hathaway, 2003; Bonn-Miller et al., 2007; Lee et al., 2007). This study will consider some of these related variables, with a particular focus on the evaluation of the personal expectancies among adolescents.

While no causal link has been established between expectancies and cannabis use, explicit expectancies are specifically associated with the frequency and severity of use (Galen and Henderson, 1999; Simons and Arens, 2007; Hayaki et al., 2010). For example, negative effect expectancies were found in adult non-users, whereas relaxation and craving effect expectancies were reported by adult cannabis users (Galen and Henderson, 1999). In adolescents and young adults, positive effect expectancies (e.g., euphoric effects, relaxation, stress reduction) are related to increased frequency of cannabis use (Aarons et al., 2001; Willner, 2001; Alfonso and Dunn, 2007; Kristjansson et al., 2012), while negative effect expectancies (e.g., harmful effects on health or behavioral control) are associated with reduced frequency (Simons and Arens, 2007).

Cannabis use expectancies thus constitute a central factor in understanding cannabis consumption, and previous studies have used various tools to assess these expectancies in adolescence. However, earlier results were exclusively based on self-report questionnaires (Young and Kavanagh, 1997; Willner, 2001; Ramo et al., 2013), which are associated with a wide range of biases related to self-representation, introspective limits and social desirability (Nisbett and Wilson, 1977; Schwarz, 1999; Blaison et al., 2006). Implicit measures based on experimental tasks have therefore been developed to overcome the limitations of explicit measures. These implicit measures are widely used in addiction research to assess several cognitive processes such as attentional bias, memory association and substance-related action tendencies (Stacy and Wiers, 2010; Roefs et al., 2011). Similar tools have also been used in adolescence, and it has been found that these implicit measures constitute a reliable predictor of later alcohol use (Wiers et al., 2007; Rooke et al., 2008). Specifically for cannabis, young adult users have been shown to have significant biases in implicit measures of attention (Field, 2005; Field et al., 2006; Cousijn et al., 2013), memory (Ames et al., 2002, 2005) and substance approach (Cousijn et al., 2011). Therefore, the combination of both explicit and implicit methods is essential to efficiently evaluate cannabis use expectancies, and then to predict consumption. However, we can consider the association of these methods in two ways: (1) as two different, but complementary, means (direct vs. indirect method) to evaluate the same construct (global expectancies); (2) as suggested by the dual processes theories (Strack and Deutsch, 2004), two measures (self-report questionnaire and SC-IAT) which evaluate distinct constructs (explicit and implicit attitude). The present research will give some indications on how to consider this explicit–implicit association.

Among the implicit experimental measures, the Implicit Association Test (IAT) (Greenwald et al., 1998) and its variant, the Single-Category Implicit Association Test (SC-IAT) (Karpinski and Steinman, 2006), are most frequently used to assess memory associations. They constitute good predictors of consumer behaviors (Steinman and Karpinski, 2008). Numerous studies have used these tasks to explore implicit memory associations with alcohol (for a review, see Roefs et al. (2011)), notably among adolescents (Thush and Wiers, 2007; Wiers et al., 2007; Thush et al., 2008). However, very little is known concerning implicit cannabis use effect expectancies in adolescence. Indeed, among young adults, studies have reported that cannabis users have less negative associations for cannabis-related words (Field et al., 2004) and that heavy cannabis users have stronger implicit positive-arousal associations (Beraha et al., 2013). Another study found no correlation between cannabis use and implicit association in young adulthood (Dekker et al., 2010). Concerning adolescence in particular, Ames et al. (2007) evaluated three implicit cannabis associations and three equivalent explicit beliefs (excitation, relaxation and negative effects) among at-risk adolescents. They showed that an implicit association with excitation significantly predicted cannabis use, whereas among explicit beliefs, relaxation and negative effects predicted use. As described above, several studies have been conducted in young adults to evaluate implicit expectancies, highlighting the importance of such measures. However, although adolescence seems to be the critical period for starting cannabis use, only one study using IAT measures has assessed implicit expectancies in a sample of at-risk adolescents (Ames et al., 2007), thus limiting conclusions to this specific population. There is a clear lack of research on implicit expectancies among adolescents, especially regarding non-clinical groups with various levels of use (including abstinence). Exploring expectancies among this broader population would provide information for prevention programs, and this study will thus focus on such a population of teenagers.

In sum, expectancies could be consider in two ways: (1) explicit expectancies, namely the effects that individuals (users or not) consciously expect to feel when the substance is consumed, usually evaluated through self-report questionnaires; (2) implicit expectancies, namely the attitude that individuals (user or not) automatically manifest towards the substance-related stimuli, usually assessed through implicit measures. The above mentioned literature described different patterns of expectancies according to the level of use: (a) non-users reported more negative explicit/implicit expectancies and less positive ones; (b) at-risk users displayed more relaxation explicit expectancies, less negative ones and more excitation implicit expectancies; (c) regular users showed more positive explicit/implicit expectancies and less negative ones; (d) heavy users presented stronger relaxation/craving explicit expectancies and positive implicit association. Whereas implicit and explicit expectancies did not necessarily have the same predictive role in cannabis use (no systematic correlation between them), the nature of the association seems rather established among all levels of use: positive expectancies associated with cannabis use, negative expectancies with non-use. However, far less is known regarding both explicit and implicit measures when the use is variable or sporadic among adolescents. Such results could be put in perspective with current literature data.

As implicit expectancies constitute a crucial factor for cannabis consumption and as adolescence is the key period for developing cannabis use, the present study will present a combined exploration of implicit and explicit cannabis effect expectancies among non-clinical adolescents, who may be at an early consumption stage. Three main aims will be followed: (1) to determine the implicit expectancies related to cannabis use and to test their relationships with explicit measures (we expected to find implicit associations among all participants and correlations with explicit measures); (2) to assess the difference between cannabis users and non-users regarding these implicit/explicit expectancies (we expected to find all kinds of positive expectancies in users and negative ones in non-users); (3) among cannabis users, to evaluate the link between frequency/problems of use and explicit/implicit expectancies (we expected to find a positive correlation between frequency problems and all positive expectancies as well as a negative correlation between frequency-problems and negative expectancies).

2. Methods

2.1. Participants

One hundred and thirty teenagers (55 girls) attending school from the French-speaking region of Belgium (Liège) were enrolled in the study. All educational networks from secondary schools were represented. Participants were between 14 and 21 years of age ($M=16.40$ years, SD=1.16); 43.84% had never used cannabis (33 men; 24 women) and were classified as "non-users"; 56.16% had already used cannabis (42 men; 31 women) and were classified as "users". Concerning the mean lifetime frequency of cannabis use (73 teenagers), 23.29% had used the substance less than four times in total, 42.47% twice or less per month, and 32.88% at least once per week; this piece of information is missing for one participant. As for the mean frequency of use in cannabis users for the last three months, 65.75% had used cannabis less than once per week, 26.03% once per week or more, and 8.22% at least once per day. For the mean frequency of use for the last two weeks, 69.86% had used cannabis once or less, 23.29% at least once per week, and 6.85% at least once per day. Participants were not paid for their participation.

2.2. Materials and measures

2.2.1. Marijuana Use Form (MUF)

The MUF (Buckner et al., 2007) is a self-report measure used to assess cannabis use. Participants report whether they have ever used cannabis (lifetime cannabis use), the date of last use, and usual average frequency of use (lifetime, past 3 months, and past 2 weeks) on a 0–6 rating scale for lifetime frequency, a 0–9 rating scale for past-month frequency, and a 0–9 rating scale for past-week frequency. This questionnaire has already been used in previous studies on the same topic (Buckner et al., 2011a, 2011b, 2012). We translated the English version into French.

2.2.2. Adolescent Cannabis Problems Questionnaire – Short Form (CPQ-A-S)

This instrument was derived from the 27-item Cannabis Problems Questionnaire for Adolescents (CPQ-A; Martin et al., 2006), which is a reliable and valid indicator of cannabis use problems in adolescents. The CPQ-A-S is a short, 12-item instrument measuring cannabis use problems. The responses are dichotomous, and a positive response receives a 1-point score. A global score, associated with the intensity of problems, is obtained by summing the positive responses (Proudfoot et al., 2010). We translated the English version into French, and it demonstrated acceptable internal consistency in the present sample ($\alpha=0.71$).

2.2.3. Marijuana Effect Expectancies Questionnaire (MEEQ)

The MEEQ is a list of expectations about cannabis use (Aarons et al., 2001; Schafer and Brown, 1991), which can be completed by people with and without a history of cannabis consumption. Each item is scored on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The validated French version of the instrument for adolescents (31 items) was used (Schmits et al., 2015). The French MEEQ assesses four expectancy domains on the following subscales, containing 5–12 items: Cognitive Impairment and Negative Effects (e.g., If I have smoked cannabis, it is harder to remember things), Relaxation and Social Facilitation (e.g., I find a sense of relaxation by smoking cannabis), Perceptual Enhancement and Craving (e.g., Smoking cannabis increases my immediate desire of things), Negative Behavioral Effects (e.g., Cannabis can make me angry and makes me potentially violent). For this study, we used only three subscales, which demonstrated acceptable internal consistency in the present sample: Relaxation and Social Facilitation ($\alpha=0.81$), or "Relaxation MEEQ," Perceptual Enhancement and Craving ($\alpha=0.62$), or "Enhancement MEEQ," and Negative Behavioral Effects ($\alpha=0.66$), or "Negative MEEQ". These three subscales assessing explicit expectancies related to cannabis use were paired with the three tasks assessing implicit expectancies described below.

2.2.4. Other variables

Alcohol use was assessed with the French version (Gache et al., 2005) of the Alcohol Use Identification Test (AUDIT), which includes 10 multiple-choice items (Saunders et al., 1993). Internal consistency was good in our sample ($\alpha=0.82$). The Liebowitz Social Anxiety Scale for Children and Adolescents – Self-Reported version (LSAS-CA-SR; Masia-Warner et al., 1999) was used to evaluate social anxiety ($\alpha=0.91$ in the present sample); the French version of the scale was used (Schmits et al., 2014). Anxiety was also studied with the State-Trait Anxiety Inventory for Children-Trait Subscale (STAIC-T, Spielberger et al., 1973), which presented good internal consistency ($\alpha=0.83$). The French version was used (Turgeon and Chartrand, 2003). The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) is designed to evaluate depressive symptomatology in the general population ($\alpha=0.89$), and this study used the French version (Führer and Rouillon, 1989).

2.2.5. IAT

The IAT (Greenwald et al., 1998) evaluates implicit affective associations with cannabis. Three separate unipolar SC-IAT subscales (Karpinski and Steinman, 2006) have been adapted to assess three associations (relaxation, excitation and negative). They were presented on a computer screen with E-prime software (version 2.0, Psychology Software Tools, Inc.). Other IAT studies have used these subscales (Ames et al., 2007; Dekker et al., 2010). Each affective category was compared with a neutral category. During the tasks, participants had to classify stimuli in one target category (cannabis) and two attribute categories (relaxation/excitation/negative vs. neutral), using a left and a right response key. For example, words such as "marijuana" or "appeased" appeared, and the participant had to press the left key if the word belongs to the "relaxation" or "cannabis" category, and the right key if it belongs to the "neutral" category (cf. block 2, Table 1). Each SC-IAT session consisted in six blocks (see Table 1). The order of the combination blocks was counterbalanced across participants, like the order of the three SC-IATs. Stimuli were shown in the middle of the computer screen and the category labels were presented in the upper corners, consistent with the response assignment of the categories. The stimulus word remained on the screen until a response was generated (for the list of French words, see Table 2). When an erroneous response was given, the words "try again" appeared in the middle of the screen. The *D* score recommended by Greenwald et al. (2003) and Lane et al. (2007) was used to assess the IAT

Table 1
Example of SC-IAT session (here for the relaxation blocks).

Block	Trials	Function	Left-key response	Right-key response
1	10	Practice	Relaxation	Neutral
2	15	Practice	Relaxation Cannabis	Neutral
3	45	Test	Relaxation Cannabis	Neutral
4	10	Practice	Neutral	Relaxation
5	15	Practice	Neutral Cannabis	Relaxation
6	45	Test	Neutral Cannabis	Relaxation

Table 2
List of French words used in the three SC-IATs.

"Cannabis" words	
Joint, Marijuana, Herbe, Pétard, Haschisch	
"Relaxation" words	**"Neutral" words**
Relaxé, Détendu, Décontracté, Apaisé, Calme	Commun, Général, Indifférent, Moyen, Milieu
"Excitation" words	**"Neutral" words**
Excité, Agité, Energique, Stimulé, Actif	Normal, Indéfini, Ordinaire Central, Standard
"Negative" words	**"Neutral" words**
Désagréable, Mauvais, Insupportable Pénible, Déplaisant	Habituel, Constant, Quotidien, Objectif, Coutumier

A pre-test has been conducted among 30 participants to determine the more representative and familiar words.

effect. As described by these authors, the scoring procedure was as followed: (1) delete trials greater than 10,000 ms; (2) delete participants for whom more than 10% of trials had a latency lower than 300 ms (in the present sample, none); (3) compute the standard deviation for all trials; (4) compute the mean latency for responses; (5) compute the mean difference (Block 6 − Block 3); (6) divide difference score by its standard deviation; (7) D = the resulting ratio. Therefore, an IAT effect is calculated by considering the difference in reaction times between the two combined categorization test blocks. Participants classically respond faster when highly associated categories are given the same response key. Therefore, for example, participants with an association of cannabis and relaxation respond faster to combined cannabis-relaxation blocks than to cannabis-neutral blocks. These tasks provide three separate measures: relaxation SC-IAT effect, excitation SC-IAT effect and negative SC-IAT effect, which are interpreted as measures of implicit expectancies regarding cannabis use. As suggested by Karpinski and Steinman (2006), the reliability of the three SC-IAT has been assessed. Each SC-IAT was divided into halves and a SC-IAT score has been calculated separately for each half of the trials without dividing by the standard deviation of correct response time. The internal consistency was assessed by calculating the average inter-correlation among these scores and applying the Spearman–Brown correction to compensate the underestimate. The adjusted reliability coefficients (comparable to the Cronbach's alphas) are 0.93 (relaxation SC-IAT), 0.87 (excitation SC-IAT) and 0.93 (negative SC-IAT), suggesting good internal consistency for these implicit measures.

2.3. Procedure

After providing their informed consent, participants performed the three cannabis SC-IATs on a computer to evaluate implicit associations (described as "implicit expectancies"). The testing procedure was performed individually in the presence of the researcher. Like the order of the combination blocks, the order of the three SC-IATs was counterbalanced across participants, with break time (a few minutes) between each of them. Then, a self-report questionnaire was administered to collect sociodemographic data, along with the questionnaires on cannabis use (MUF), problems related to cannabis use (CPQ-A-S), cannabis use effect expectancies (MEEQ), alcohol use (AUDIT), trait anxiety (STAIC-T), social anxiety (LSAS-CA-SR) and depression (CES-D). The study protocol was approved by the University's Institutional Review Board (University of Liège, Belgium).

2.4. Data analysis

Sample characteristics were determined using X^2 and Student's t tests. SC-IAT effects were analyzed with Student's t test. Pearson's, Spearman's and partial correlations were conducted between cannabis-related variables (frequencies and problems), expectancy-related variables (MEEQ scores and SC-IAT scores) and internalizing factors (depression, anxiety and social anxiety). The relationship between various explicit/implicit expectancies and prevalence of cannabis use was evaluated using two-way mixed ANOVAs with repeated measures. A sphericity test was systematically conducted. When the sphericity condition was not met, the Greenhouse–Geisser Correction for repeated measures was applied, considering the adjusted degrees of freedom and p-value. All statistical analyses were performed using the software package Statistica 10 (StatSoft, Inc., Maisons-Alfort, France), with the α level set at 0.05.

3. Results

3.1. Descriptive statistics

Table 3 presents the characteristics of the whole sample and the two subsamples (non-users and users). Non-users and users groups did not significantly differ for gender, anxiety and depression. However, users showed a significantly higher mean age, more alcohol use and less social anxiety. These variables were introduced as covariates for each analysis in order to control for their influence on the experimental measures.

3.2. SC-IAT effects (implicit expectancies) among adolescents

SC-IAT effects were evaluated with Student's t tests to assess the difference from zero. All were significant for the whole sample, the non-users and the users (see Table 4). Both groups manifested more affective implicit associations (relaxation, excitation and negative) than neutral implicit associations concerning cannabis. Means and standard deviations for the three MEEQ subscales (explicit expectancies) are also reported in Table 4.

3.3. Correlations between the different measures of cannabis expectancies

As shown by the Pearson's correlations presented in Table 5, after controlling for age, alcohol use and social anxiety, implicit measures (SC-IAT effects) were not significantly associated with explicit measures (MEEQ subscales) for the whole and users' samples.

3.4. Associations between lifetime cannabis use and explicit expectancies (MEEQ subscales)

A 2 × 3 repeated measures ANOVA with group (users, non-users) as a between-subject variable and MEEQ score (relaxation, enhancement, negative) as a within-subject variable was conducted. Both a significant group effect [$F(1,127) = 19.29$, $p < 0.001$] and a significant MEEQ score effect [$F(2,254) = 56.33$, $p < 0.001$] were found. Considering each MEEQ subscale separately, Relaxation MEEQ and Enhancement MEEQ did not differ significantly according to group (non-users vs. users), whereas Negative MEEQ was higher among non-users [$F(1,127) = 81.93$, $p < 0.001$]. Moreover, a post-hoc test was conducted, which revealed a significant difference between all MEEQ subscales, with Relaxation MEEQ (Mean = 3.50) > Enhancement MEEQ (Mean = 3.03) > Negative MEEQ (Mean = 2.65). The interaction between lifetime cannabis use and MEEQ subscales was also significant [$F(2,254) = 29.84$, $p < 0.001$]. Non-users had the following MEEQ subscale scores: Relaxation MEEQ (Mean = 3.61) > Negative MEEQ (Mean = 3.24) > Enhancement MEEQ (Mean = 2.99). On the other hand, cannabis users had the following scores: Relaxation

Table 3
Participants' characteristics.

	Whole sample ($n=130$)	Non-users ($n=57$)	Users ($n=73$)	Statistical test	dl	p-Value
Gender, n (M/W)	75/55	33/24	42/31	$X^2=0.001$	1	0.97
Age, mean (SD)*	16.70 (1.16)	16.28 (1.10)	17.02 (1.10)	$t=3.83$	128	<0.001
Alcohol use, mean (SD)*	7.78 (5.68)	4.11 (3.59)	10.67 (5.36)	$t=7.93$	127	<0.001
Anxiety, mean (SD)*	36.08 (7.18)	37.37 (7.72)	35.06 (6.60)	$t=-1.85$	128	0.06
Depression, mean (SD)*	14.39 (9.71)	14.05 (9.75)	14.65 (9.75)	$t=0.35$	128	0.73
Social anxiety, mean (SD)*	30.17 (17.97)	34.67 (18.05)	26.59 (17.20)	$t=-2.59$	127	0.01

For gender, M=Men and W=Women.

* Tolerance of homogeneity of variance (for Levene's test, $p>0.05$).

MEEQ (Mean=3.41) > Enhancement MEEQ (Mean=3.06) > Negative MEEQ (Mean=2.20) (see Fig. 1).

Main and interaction effects remained significant after controlling for age [for group effect, $F(1,126)=14.22$, $p<0.001$; for MEEQ score effect, $F(2,252)=3.58$, $p=0.02$; for interaction, $F(2,252)=30.65$, $p<0.001$], social anxiety (for group effect, $F(1,125)=19.63$, $p<0.001$; for MEEQ score effect, $F(2,250)=20.20$, $p<0.001$; for interaction, $F(2,250)=24.81$, $p<0.001$) and alcohol use [for group effect, $F(1,125)=18.61$, $p<0.001$; for MEEQ score effect, $F(2,250)=7.32$, $p<0.001$; for interaction, $F(2,250)=15.01$, $p<0.001$].

3.5. Associations between lifetime cannabis use and implicit expectancies (SC-IAT effects)

A 2×3 repeated measures ANOVA with group (users, non-users) as a between-subject variable and SC-IAT score (relaxation, excitation, negative) as a within-subject variable was conducted. No significant group effect was found [$F(1,128)=3.02$, $p=0.08$], nor was there a significant SC-IAT score effect [$F(2,256)=2.70$, $p=0.07$]. As the SC-IAT score effect was nearly significant ($p=0.07$), each SC-IAT was considered separately. Whereas the excitation and negative SC-IATs did not differ significantly according to group (non-users or users), the relaxation SC-IAT effect was higher among cannabis users [$F(1,128)=3.93$, $p=0.04$].

The interaction between lifetime cannabis use and SC-IAT effects was not significant [$F(2,256)=0.78$, $p=0.46$]. Non-users and users presented the same hierarchy of SC-IAT mean scores: Excitation SC-IAT effect > Relaxation SC-IAT effect > Negative SC-IAT effect, with a significant difference only between the mean score for excitation and the mean score of negative SC-IAT (see Fig. 2).

Concerning main and interaction effects, findings were similar after controlling for age (for group effect, $F(1,127)=2.82$, $p=0.09$; for IAT score effect, $F(2,254)=0.69$, $p=0.49$; for interaction, $F(2,254)=1.14$, $p=0.31$) and social anxiety [for group effect, $F(1,126)=3.39$, $p=0.06$; for IAT score effect, $F(2,252)=0.75$, $p=0.47$; for interaction, $F(2,252)=0.69$, $p=0.50$]. However, when alcohol use was included, the main effect of group became significant [$F(1,126)=4.88$, $p=0.02$], with higher SC-IAT effects for cannabis users. Other effects remained non-significant (for IAT score effect, $F(2,252)=1.20$, $p=0.30$; for interaction, $F(2,252)=0.20$, $p=0.81$).

3.6. Associations between frequencies/problems related to cannabis use and explicit expectancies among cannabis users

As shown in Table 6, all frequencies of use, as well as the problems related with cannabis use, were significantly positively correlated with the relaxation and enhancement MEEQs. Frequency of use over the lifetime and in the past three months was negatively correlated with Negative MEEQ. The same significant results were found when age, social anxiety and alcohol use were introduced as control variables, and when explicit expectancies were controlled (for the correlation between frequency and implicit expectancies, and inversely).

3.7. Associations between frequencies/problems related to cannabis use and implicit expectancies among cannabis users

No correlation was found between the Relaxation and Excitation SC-IATs and frequencies and problems related to cannabis use. However, the Negative SC-IAT was negatively correlated with lifetime frequency of use and with problems related to cannabis use (Table 6). The same results were found when age and social anxiety were introduced as control variables. However, when alcohol use was considered, the correlation between Negative SC-IAT and lifetime frequency of use became non-significant ($r=-0.21$).

Table 4
IAT effect and means for MEEQ subscales in the whole sample and the two subsamples.

	Whole sample ($n=130$)		Non-users ($n=57$)		Users ($n=73$)	
	Mean (SD)	t (dl)	Mean (SD)	t (dl)	Mean (SD)	t (dl)
Relaxation SC-IAT	0.19 (0.32)	6.91 (129)**	0.13 (0.29)	3.40 (56)*	0.24 (0.33)	6.21 (72)**
Excitation SC-IAT	0.25 (0.34)	8.36 (129)**	0.21 (0.34)	4.58 (56)**	0.28 (0.34)	7.15 (72)**
Negative SC-IAT	0.16 (0.33)	5.58 (129)**	0.15 (0.37)	3.12 (56)*	0.17 (0.30)	4.80 (72)**
	Mean (SD)		Mean (SD)		Mean (SD)	
Relaxation MEEQ	3.50 (0.76)		3.61 (0.67)		3.41 (0.82)	
Enhancement MEEQ	3.03 (0.68)		2.99 (0.49)		3.06 (0.80)	
Negative MEEQ	2.65 (0.83)		3.24 (0.61)		2.20 (0.67)	

The D score recommended by Lane et al. (2007) was used to assess the IAT effect. An IAT effect is calculated by considering the difference in reaction times between the two combined categorization test blocks.

* Statistically different from zero with $p<0.05$.

** Statistically different from zero with $p<0.001$.

Table 5
Partial correlations between SC-IAT effects and MEEQ subscales among the whole sample ($n=130$) and the users' sample ($n=73$).

	Relax MEEQ		Enhancement MEEQ		Negative MEEQ	
	Whole sample	Users	Whole sample	Users	Whole sample	Users
Relaxation SC-IAT	$r=-0.04$ $p=0.63$	$r=-0.21$ $p=0.08$	$r=-0.04$ $p=0.64$	$r=-0.07$ $p=0.57$	$r=-0.12$ $p=0.16$	$r=-0.10$ $p=0.40$
Excitation SC-IAT	$r=0.02$ $p=0.81$	$r=0.03$ $p=0.79$	$r=-0.11$ $p=0.23$	$r=-0.08$ $p=0.48$	$r=-0.07$ $p=0.43$	$r=0.06$ $p=0.62$
Negative SC-IAT	$r=-0.04$ $p=0.60$	$r=-0.03$ $p=0.80$	$r=-0.06$ $p=0.49$	$r=-0.17$ $p=0.14$	$r=0.04$ $p=0.72$	$r=0.04$ $p=0.72$

Relax MEEQ=Relaxation and Social Facilitation subscale of the MEEQ; Enhancement MEEQ=Perceptual Enhancement and Craving subscale of the MEEQ; Negative MEEQ=Negative Behavioral Effects subscale of the MEEQ. Age, alcohol and social anxiety were the control variables.

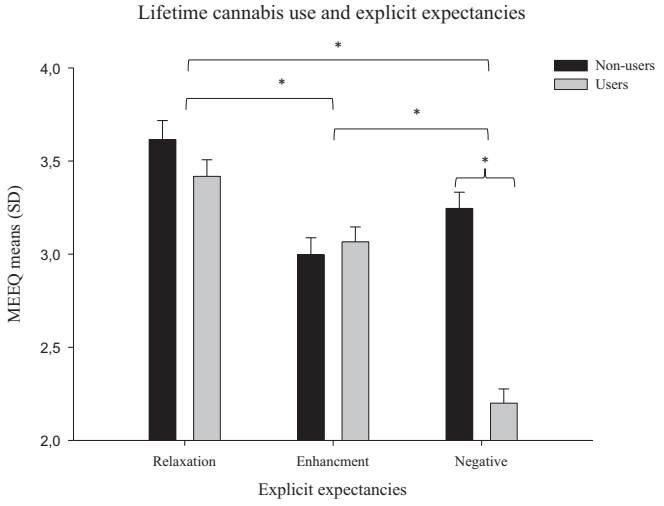

Fig. 1. Lifetime cannabis use and explicit expectancies. *Significant difference with $p<0.05$.

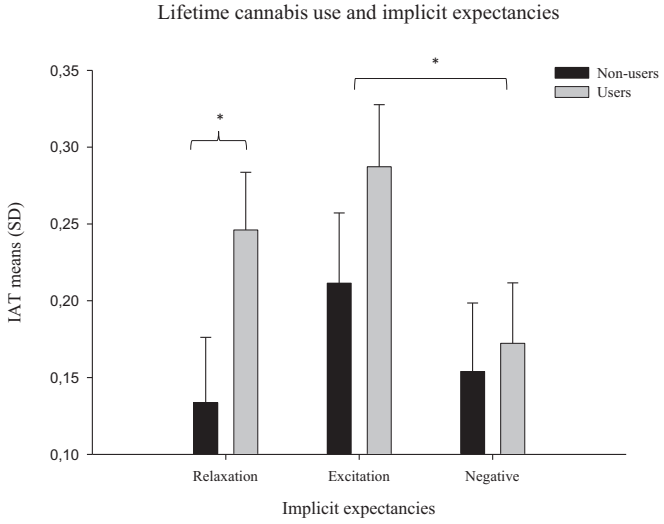

Fig. 2. Lifetime cannabis use and implicit expectancies. *Significant difference with $p<0.05$.

4. Discussion

This study was the first to investigate explicit and implicit cannabis effect expectancies through memory association in a non-clinical sample of adolescents. It provided information on explicit and implicit expectancies in non-clinical adolescents, at all levels of cannabis use (including abstinence).

The first aim was to determine what the implicit associations concerning cannabis effects might be and their correlations with explicit measures. Results showed significant SC-IAT effects (memory associations) for all implicit expectancies, independently of the group. This shows that adolescents in the general population manifest more affective implicit associations (relaxation, excitation and negative) than neutral implicit associations about cannabis. This effect might be explained by the presence of actual negative and positive memory associations with cannabis among adolescents: on the one hand, they might view cannabis negatively, due to cultural, media (Dekker et al., 2010) or parental stigmatization; on the other hand, they might consider the substance positively, due to its relaxing and exciting effects and the potential prestige it can create in the eyes of peers. Similar results have also been found for alcohol in heavy users (Wiers et al., 2007). Another possible explanation is based on the nature of the stimuli (words related to cannabis), which were inherently more stimulating than neutral words. The adolescents may have had an affective association with the concept of cannabis, and could have manifested simultaneous positive (relaxation, excitation) and negative implicit memory associations.

Regarding correlations between implicit (memory associations measured by SC-IAT effects) and explicit (MEEQ) measures, no significant relationship was identified, neither for the whole sample nor for cannabis users. First, we can consider that both explicit and implicit measures are two complementary ways to assess the same construct (in which case a correlation between them would have been found). The maintenance of significant correlations between frequency and explicit expectancies despite the control of implicit ones (and inversely) also support this idea. The absence of relationship might also reflect a gap in the construct validity. However, our results suggest a clear discrepancy between implicit and explicit measures, suggesting that they assess divergent constructs. As Beraha et al. (2013) suggested, implicit and explicit measures could rely on different motivational processes. Indeed, Hofmann et al. (2005) highlighted several possible explanations for the low correlations between explicit and implicit measures, including motivational influences that could bias explicit measures (e.g., social desirability) but not implicit ones. In addition, they suggested that implicit measures express specific characteristics (which are not supported by explicit ones): a lack of introspection concerning representations or the retrieval of information from memory influenced by other factors. Finally, they also may measure constructs that are completely independent (Hofmann et al., 2005), as they have different associations with the frequency of cannabis-related problems. Divergences among such measures could have implications not only at the experimental or theoretical levels but also regarding the evaluation of constructs such as expectancies at a clinical level.

The second aim was to assess the difference between non-users and users regarding implicit and explicit expectancies. The results indicated that cannabis users had more relaxation-related implicit

Table 6
Correlations between frequency of cannabis use (Spearman's Test), problems related to cannabis use (Pearson's Test) and SC-IAT effects, and MEEQ subscales among cannabis users ($n=73$).

	Relaxation SC-IAT	Excitation SC-IAT	Negative SC-IAT	Relaxation MEEQ	Enhancement MEEQ	Negative MEEQ
Lifetime frequency	$r=0.02$	$r=-0.18$	$r=-0.30$	$r=0.34$	$r=0.35$	$r=-0.38$
	$p=0.86$	$p=0.13$	$p=0.001$	$p=0.003$	$p=0.002$	$p=0.001$
Frequency in the past 3 months	$r=0.06$	$r=-0.06$	$r=-0.14$	$r=0.27$	$r=0.28$	$r=-0.27$
	$p=0.61$	$p=0.61$	$p=0.23$	$p=0.02$	$p=0.01$	$p=0.01$
Frequency in the past 2 weeks	$r=-0.04$	$r=-0.06$	$r=-0.17$	$r=0.37$	$r=0.32$	$r=-0.22$
	$p=0.71$	$p=0.58$	$p=0.12$	$p=0.001$	$p=0.005$	$p=0.05$
Problems	$r=0.02$	$r=-0.12$	$r=-0.30$	$r=0.34$	$r=0.43$	$r=-0.17$
	$p=0.91$	$p=0.42$	$p=0.01$	$p=0.008$	$p<0.001$	$p=0.17$

Relaxation MEEQ=Relaxation and social facilitation subscale of the MEEQ; Enhancement MEEQ=Perceptual Enhancement and Craving subscale of the MEEQ; Negative MEEQ=Negative Behavioral Effects subscale of the MEEQ.

expectancies, while non-users experienced more negative explicit expectancies. No differences were found for the other indices. In other words, adolescents who had already tried cannabis reported more relaxation implicit expectancies and less negative explicit expectancies. Similar results had been reported for adult heavy cannabis users (Beraha et al., 2013). Our results thus generalize this observation to the onset of cannabis use in adolescence. However, contrasting with other findings (Field et al., 2004; Beraha et al., 2013), non-users did not show higher negative implicit associations, but only higher negative explicit expectancies (Gaher and Simons, 2007). Moreover, implicit and explicit expectancies regarding excitation or enhancement did not differ between users and non-users, contrasting with previous studies suggesting that explicit and implicit excitation expectancies about cannabis could constitute a significant predictor of cannabis use (Galen and Henderson, 1999; Ames et al., 2007). It might therefore be suggested that positive expectancies gradually develop as a consequence of substance use and are not strongly present at the early consumption stages. Users reported their explicit expectancies after they had already tried cannabis, probably based on the experienced sensations, whereas non-users relied on their subjective feelings (Shrier and Scherer, 2014). Despite these discrepancies, their expectancies did not differ, suggesting that, at the early stages of use, both users and non-users expect positive effects.

Third, frequency of use and associated problems were positively correlated with explicit relaxation and enhancement expectancies, and negatively correlated with negative implicit and explicit expectancies. This suggests that positive explicit expectancies might be a stronger predictor of increased use. Conversely, frequency of use may have influenced these expectancies by reinforcing positive ones and decreasing negative ones due to the actual experience of cannabis effects. Our experimental design does not allow us to conclude about the causality of these relationships and longitudinal data are thus needed. In contrast, Beraha et al. (2013) found that higher cannabis use was associated with more negative implicit associations, whereas more frequent use-related problems were associated with stronger negative explicit expectancies. This inconsistency can be explained by the fact that these authors assessed young adults who were heavy cannabis users, whereas our study focused on adolescents starting cannabis use and thus not facing serious cannabis-related problems yet. In fact, expectancies may change during the consumption trajectory, ranging from occasional use to abuse or dependence, when the substance is no longer used for its positive effects (as it is often the case for occasional adolescent users) but rather to avoid its negative effects (e.g. withdrawal or craving found in heavy users). This mechanism is often reported for alcohol use (Robinson and Berridge, 1993).

To sum up, all adolescents manifested implicit affective associations (relaxation, excitation and negative) with cannabis, but these were not necessarily related to explicit associations. Cannabis users reported more implicit relaxation expectancies and less explicit negative expectancies than non-users. The frequency of and problems related to use were strongly influenced by all kinds of explicit expectancies but only by negative implicit ones. These findings revealed that implicit and explicit expectancies play different and relevant roles in cannabis use among adolescents.

While future studies should extend the present results to heavy cannabis users, particularly in longitudinal designs exploring the changes in expectancies during the successive addiction stages, our findings indicated that cannabis users not only reported more positive implicit expectancies than non-users, but their positive explicit expectancies were related to the frequency of use and related problems. Conversely, explicit negative expectancies were associated with a decrease in the frequency of use. Considering both implicit and explicit ones would allow an integrative approach to cannabis use. Attentional retraining programs could also be considered, as it was developed for alcohol (Wiers et al., 2011, 2014). Moreover, according to other studies, the influence of explicit and implicit expectancies seems to evolve with age and the stage of use, suggesting that they could change according to use and highlighting the need to properly contextualize assessment and intervention.

Conflict of interest

Authors declare that they have no conflict of interest.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.psychres.2015.11.005.

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