Risk factors for substances use and misuse among young people in France: what can we learn from the Substance Use Risk Profile Scale?

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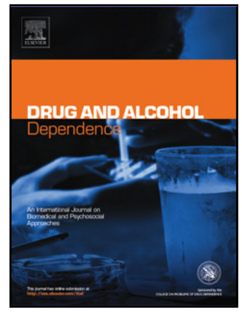
Accepted Manuscript



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PII: S0376-8716(16)30030-8
DOI: http://dx.doi.org/doi:10.1016/j.drugalcdep.2016.03.027
Reference: DAD 6003

To appear in: *Drug and Alcohol Dependence*

Received date: 4-11-2015
Revised date: 8-3-2016
Accepted date: 29-3-2016

Please cite this article as: Ali, A., Carré, A., Hassler, C., Spilka, S., Vanier, A., Barry, C., Berthoz, S., Risk factors for substances use and misuse among young people in France: what can we learn from the Substance Use Risk Profile Scale?.Drug and Alcohol Dependence http://dx.doi.org/10.1016/j.drugalcdep.2016.03.027

Risk factors for substances use and misuse among young people in France: what can we learn from the Substance Use Risk Profile Scale?

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Highlights

- The SURPS measurement invariance was confirmed across gender and three age bands
- Hopelessness, Impulsivity and Sensation Seeking are risk factors for drug-use
- Anxiety Sensitivity is a protective factor for Alcohol, Tobacco and Cannabis use
- There exist genuine differences on personality scores between boys and girls
- Interactions between personality traits and gender should always be investigated

ABSTRACT

Background: The prevention of addictions in young people is a challenge for Mental and Public Health policies, and requires specific risk-screening tools. Specific personality traits, as assessed using the Substance Use Risk Profile Scale (SURPS), could play a key role in the onset and escalation of substance use. This study aimed to examine 1) measurement invariance across age and gender (2) the effects of age and gender on associations between SURPS scores and the most frequently-consumed substances.

Methods: Analyses were based on the responses from 5,069 participants (aged 14 to 20 years) from the 2011 ESPAD-France dataset. Substance-use outcomes were experimentation and current frequency of alcohol, tobacco and cannabis use, and drunkenness.

Results: Our approach, consisting in analysing measurement and structural invariance and interaction terms, established the stability of i) SURPS profiles, and ii) relationships between these scores and substance experimentation and use over a developmental period ranging from mid-adolescence to early adulthood. Measurement invariance across genders was also confirmed despite the absence of scalar invariance for 2 items. Significant interactions between gender and SURPS factors were established, highlighting differential vulnerability, especially concerning hopelessness and experimentation of alcohol and drunkenness, or Impulsivity and tobacco experimentation. Finally, anxiety sensitivity could be protective against substance use, especially for cannabis in girls.

Conclusions: Our results suggest the relevance of the SURPS to assess vulnerability towards drug use, and underline the need to consider gender differences in addiction risks.

KEYWORDS: Prevention, Addiction, Personality, Gender, Adolescence, Measurement Invariance

1. INTRODUCTION

Despite the growing number of prevention campaigns, drug and alcohol consumption in adolescence and early adulthood remains a major concern in developed countries (WHO, 2012). The most widely consumed substance is alcohol, followed distantly by tobacco and cannabis, with respectively 57% of 15-16 year-old European students reporting current (past month) alcohol consumption, 28% cigarette use and 7% cannabis use (Hibell et al., 2012). Since alcohol and drug exposure early in life is known to impact socio-affective development (academic and professional achievement, mental health) and to be important contributing factors to psychiatric vulnerability (Batel, 2000; Chambers et al., 2003), these data call for increased prevention efforts. One strategy considered promising is to gain knowledge on the people more at risk. Indeed, besides the influence of environmental factors (e.g., parental educational level, parenting practices, peer influence), there is accumulating evidence that some individuals are predisposed, and that the interplay between specific personality traits and environmental conditions could play a key role in the onset, escalation and later development of substance misuse and dependence (Ersche et al., 2012). Motivational models and characterization of specific personality profiles for substance misuse and associated assessment instruments have thus progressively emerged (Cox and Kingler, 1988; Cooper, 1994; Conrod et al., 2000).

The Substance Use Risk Profile Scale (SURPS) is a brief self-report questionnaire that was elaborated to measure personality and affect-related styles liable to increase risks of engaging in substance misuse and abuse (Conrod et al., 2000; Woicik et al., 2009). The SURPS evaluates four distinct personality traits that have been consistently associated with intensive and problematic drug use: Impulsivity (IMP), Sensation Seeking (SS), Hopelessness/Negative Thinking (H/NT), and Anxiety Sensitivity (AS; Woicik et al., 2009). This self-report has been adapted into Chinese (Siu, 2011), Dutch (Malmberg et al., 2010), French (Castonguay-Jolin et al., 2013), German (Jurk et al., 2015), Japanese (Omiya et al., 2015), Korean (Saliba et al., 2014), Portuguese (Canfield et al., 2015), Sinhala (i.e., Sri Lanka; and Spanish (Robles-García et al., 2014). Overall, the SURPS appears to have a stable four-factor structure with satisfactory internal consistency and test-retest reliability, and has demonstrated both convergent and discriminant relationships with theoretically relevant measures of personality and motivations for substance use. The SURPS H/NT, IMP and SS scores have been repeatedly associated with an increased risk for current and later substance (mis)use in adolescent and adult samples (see Table 1 for a summary of key validation studies on SURPS predictive validity). Regarding SURPS AS scores, as illustrated in Table 1, results are inconsistent: a minority of studies reported the expected increased risk for substance use (mostly alcohol-related, e.g. quantity per drinking occasion and problematic drinking), while the remaining studies reported either no effect or a protective effect. To account for these inconsistencies, and in line with the documented relationship of AS with substance (mis)use in adults or in clinical samples (Schlauch et al., 2015), it has been hypothesized that AS might influence substance use differently in early and late adolescence (Woicik et al., 2009; Krank et al., 2011; Castellanos-Ryan et al., 2013; Lammers et al., 2013; Malmberg et al., 2013; Peeters et al., 2014).

Besides age, gender is also likely to contribute to our understanding of the mechanism linking personality and substance use (Castellanos-Ryan and Conrod, 2012) . Indeed, whereas boys generally show higher levels of substance use than girls, it seems that these gender differences vary in the course of development, with the smallest differences at the youngest ages, and the largest during the transition from late-adolescence to adulthood (Kuhn, 2015). There is also evidence for gender differences in personality traits in general and for higher SURPS AS and H/NT scores, but lower SS scores among females/girls than males/boys (Malmberg et al., 2010; Castonguay-Jolin et al., 2013; Hustad et al., 2014). However, relatively few studies that examined gender differences in substance (mis)use simultaneously investigated different dimensions of personality vulnerability.

To correctly interpret interactive effects of age/gender and these personality traits, we need first to determine whether the underlying psychometric properties of the scales are invariant (i.e., equivalent) across age/gender (Gregorich, 2006). Indeed, age/gender differences could manifest themselves (Richardson et al., 2011) at structural level (e.g., differences in the number of dimensions) or at item level (e.g., differential item meanings, differential acquiescence response styles). For instance, socio-cultural norms within genders might systematically produce lower self-reported scores to the AS items among men compared to women, as it is culturally less acceptable for men to report being “frightened or scared” (whatever the level of AS). Importantly, these gender-specific cultural norms may evolve through adolescence and thus apply differently to younger *vs.* older adolescents. Thus if Measurement Invariance (MI) across age/gender does not hold, total score differences across age/gender groups are difficult to interpret, as they could result either from measurement differences or from genuine personality differences. To date, the French version of the SURPS has been validated in a Canadian sample of 15-year-olds (Castonguay-Jolin et al., 2013) and a French sample of 13-15-year-olds (Jurk et al., 2015). The question whether the four-factor structure is reliable in older French-speaking cultures and is invariant between younger and older adolescents’ remains. Moreover, besides the pivotal study by Woicik and colleagues (Woicik et al., 2009) among adults (mean age 19.3), the MI across genders of the SURPS has only been assessed among 13 to 15 year-old adolescents [Western Canadians: (Memetovic et al., 2014); in a mix of English, French and German adolescents: (Jurk et al., 2015)], and there is a need to further investigates this issue among older adolescents.

Here, we sought to further validate the SURPS in a French-speaking sample using a representative community sample of young people aged 14 to 20 years. We aimed (1) to replicate the factorial structure among both adolescents and young adults and to confirm measurement invariance across genders, (2) to examine effects of age and gender on associations between SURPS scores and the most widely consumed substances.

2. METHODS

2.1 Participants

A school-based population survey was conducted in France in 2011 as a part of the ESPAD study. Sampling and data collection procedures are summarized here; full details have been reported in the 2011 ESPAD Report (Hibell et al., 2012).

Briefly, a national representative sample of 9–12th grade students was randomly selected in 198 schools (junior and senior high school, and vocational school) and 396 classes. At the time of the survey, 87% of the students were present. Standardized data collection was performed using an anonymous self-administered questionnaire completed on a voluntary basis in the classroom setting, including individual/demographic information, the SURPS, and data on alcohol, tobacco and illicit substance use. The current analysis was performed on the 5069 high school students (14-20 years old) who fully completed the SURPS.

2.2 Measures

2.2.1 Substance Use Risk Profiles Scales (SURPS). The English version of the SURPS has been translated into French, implementing standard methods of translation and reverse translation (Castonguay-Jolin et al., 2013). We used the shorter 20-item version (Krank et al., 2011): 7 items for H/NT (Hopelessness, introversion, bleak expectations about oneself and the future); 4 items for IMP (lack of premeditation, and difficulties with response inhibition); 4 items for SS (need for intense and novel experiences), and 5 items for AS (a fear of anxiety-related physical sensations). Participants rate each item on a 4-point Likert scale. Subscale scores were computed by calculating the average score for each item in the subscales (Woicik et al., 2009).

2.2.2 Substance use behaviours. From the ESPAD questionnaire, four indicators of substance use were taken into account: (i) cigarette (ii) cannabis (iii) alcoholic beverages (iv) drunkenness.

Responses to the following questions were used: On how many occasions (if any) have you: (i) smoked cigarettes? (ii) used marijuana or hashish (cannabis)? (iii) had any alcoholic beverage to drink? (iv) been intoxicated from drinking alcoholic beverages, for example staggered when walking, not being able to speak properly, throwing up or not remembering what happened? [In your lifetime / In the last 30 days]

For each indicator, the two outcomes analysed here were experimentation and frequency of current consumption. Experimentation was defined according to lifetime answers (on at least one occasion in lifetime). Frequency of current consumption was estimated from the last 30 days response among the participants who reported having experimented the substance.

2.3 Data Analyses

2.3.1 Measurement and structural invariance across age and gender. The invariance of the four SURPS factors was examined by means of a series of multiple group confirmatory factor analyses (CFA) comparing factor structure across gender and three age bands ([14-15], [16-17], [18-20]). This stratification was defined on the basis of age criteria that are potentially associated with changes in substance consumption in France. The class of the participants over the legal age to purchase alcohol and tobacco in France (i.e., 18 years old) was first created. The two other classes were created on the basis of the mean age of transition from secondary school to high school (i.e., 16 years old), as it has been documented that it is one of the most critical periods for cannabis escalation of consumption in France (e.g., see Spilka and Le Nézet 2013).

In accordance with the procedure recommended by Krank et al. (2011), these CFAs were conducted using the Maximum Likelihood estimator with 'Huber-White' Robust standard errors (MLR) with Yuan-Bentler-like correction. The procedure rests on a series of nested models where an increasing number of measurement and structural parameters are constrained to be equal across groups, with each additional constraint defining an increasing level of invariance. The following levels of invariance (models) were tested consecutively (1) configural invariance (the only constraint is that each factor is associated with identical item sets across groups); (2) metric invariance (equal factor loadings across groups); (3) strong invariance (equal factor loadings and intercepts); (4) strict factorial invariance (equal factor loadings, intercepts and error variances; Gregorich, 2006; Meredith and Teresi, 2006). Configural invariance can be considered as a type of baseline invariance and is evaluated by examining overall fit. A substantial decrease in goodness-of-fit with increasingly constrained models suggests non-invariance of the given set of parameters across groups.

A variety of guidelines have been proposed to compare the fit for the two nested models representing different levels in the hierarchy of measurement invariance; the general recommendation is to rely on Δ comparative fit index [i.e., the Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA)] rather than on the chi-square test difference, given the well-known marked sensitivity of the latter to sample size (Cheung and Rensvold, 2002; Chen, 2007). As proposed recently (Marsh et al., 2013) measurement invariance is considered to be supported if any decrease in the values (Δ) is $\Delta CFI \leq 0.01$ and $\Delta RMSEA < 0.015$. When a substantial decrease in goodness-of-fit is found, modification indices are used to identify which items are non-invariant and then the equivalence constraint is relaxed for these failing items. Partial invariance is an acceptable alternative when complete invariance cannot be reached (Cheung and Rensvold, 1999). An item that is shown to be non-equivalent across groups at a specific level of invariance remains unconstrained in the investigation of the next levels of invariance.

In case of support for measurement invariance (full or partial), analyses of structural invariance are then carried out assessing the equivalence of the latent factor means across groups. Structural non-invariance is typically not a focus of measurement bias, but concerns how the latent factors are distributed in the different groups. Hence, assuming measurement invariance, structural invariance enables genuine differences across groups, such as de-differentiation of some latent traits across ages, to be evidenced.

The R lavaan package (Rosseel, 2012) was used to conduct all CFAs.

2.3.2 Effect of age and gender on the relationships between SURPS scores and substance use. Associations between personality traits with substance use were tested by means of multiple regression analyses (logistic and quasi-Poisson multiple regression models) with, respectively, experimentation or frequency of current consumption as outcome measures and SURPS subscales, age and gender as predictors. All SURPS subscale scores were entered into each model simultaneously in order to estimate unique effects of each trait. Age or gender differences in these relationships between personality traits and substance use were assessed by adding each possible interaction term between SURPS subscales and age or gender to the regression models. Interaction terms were retained in the final model only if significant. Parental educational level was also included as a covariate given its established influence on adolescent substance use. In addition, the school and the class were included as random effects to take into account the clustered nature of the ESPAD data.

A probability level of $p < 0.05$ was used to indicate statistical significance. Regarding interaction analyses, owing to their exploratory nature in the present study, no adjustments for multiple testing were made (Bender and Lange, 2001).

3. RESULTS

3.1 Descriptive Statistics

Of the 5,069 secondary school students, 2,331 (46%) were male and 2,738 (54%) female. Experimentation rates (life-time prevalence) and frequency of substance use in the month prior to the survey are presented in Table 2. Overall, 68% of the sample had smoked at least once in their life-time, 46% had experimented with cannabis, most (92%) had consumed alcoholic drinks at some time and 57% had experienced drunkenness. Almost all the adolescents first ever experimented alcohol before 14-15 years of age and this rate remained constant thereafter, while the proportion of adolescents who first ever experimented tobacco, cannabis or drunkenness steadily increased for each age group. Furthermore, among users, the frequencies of use (alcohol, tobacco or cannabis) and of drunkenness increased significantly across the span of age tested. With the exception of tobacco, boys reported significantly higher substance use than girls.

3.1.1 Invariance of the four-factor model across age and gender. Prior to the multiple-group analyses, the goodness-of-fit values for the four-factor CFA model on French adolescents and young adults were examined. The fit indices of the single group model were CFI=0.926; RMSEA=0.041; SRMR=0.046, thereby confirming the validity of the four-factor structure of the SURPS. Table 3 shows the fit statistics for invariance testing across age and gender. The multiple-group baseline models in which items were constrained to load on the same factors across boys and girls or age groups (model G1 and A1 respectively) demonstrated adequate to good fit [*i.e.* CFI > 0.90, RMSEA < 0.05] supporting configural invariance across all subgroups.

Regarding invariance across age groups, constraining the models further to have successively equivalent factor loadings (A2), equivalent item intercepts (A3) and equivalent item residual variance (A4) across the subgroups led to improvements in RMSEA values and minor CFI weakening reaching a maximum of 0.002. Hence, full measurement invariance was established.

Regarding invariance across gender, equivalence of factor loadings across boys and girls was supported by the small difference of fit between the models assuming metric and configural invariance. However constraining item intercepts further to be equal for boys and girls (G3) resulted in a fit deterioration (ΔCFI=-0.013) slightly greater than the Cheung and Rensvold's criteria (i.e., -0.01). Modification indices suggested that the cross-group equality constraints on the intercept for items 2 (IMP scale) and 12 (SS scale) contributed most strongly to the lack of fit. After allowing intercepts for these items to vary across gender, the resultant model (G3b) was no longer substantially worse compared to the metric model (ΔCFI=-0.005). Examination of G3b intercept indicators showed that, independently from the construct of interest, girls were more likely than boys to endorse item 2 ("*I often don't think things through before I speak*") while they were less likely than boys to endorse item 12 ("*I would like to learn how to drive a motorcycle*"). Finally, adding equivalent item residual variances to the partial strong invariance model or to the full strong invariance one resulted in almost no change in fit (ΔCFI G3b/G4b =-0.003, ΔCFI G3/G4 =-0.004). In summary, there was reasonable support for invariance across genders of factor loadings, item intercepts (at least for 18 items out of 20) and item residual variances, which provides justification for the interpretation of comparisons of means and variances.

3.1.2 Structural invariance across age and gender. We then assessed how the latent factors were distributed and related in the different subgroups. As shown in Table 3, there was support for equivalence across ages for latent factor means, since the structural model (A5) did not differ substantially from the strict invariance model (A4). However, constraining means to be equal for boys and girls leads to a substantial decrease in goodness of fit (G5 ΔRMSEA= 0.004, ΔCFI=-0.022), which implies that these values change across the groups.

Because their intercepts were freely estimated in each group, items 2 and 12 did not contribute to the estimated group difference in factor means.

These structural gender differences were then depicted with observed SURPS manifest scores (Table 4). Boys endorsed higher SS scores than girls, and but lower AS, H/NT and IMP scores. Gender differences remained significant when only those items meeting strong factorial invariance criteria were included in calculation of IMP and SS scores (SS p<0.001, IMP p<0.001), thereby corroborating that gender differences on observed

3.1.3 Relationships between SURPS scores and substance use across age and gender. As illustrated in Table 5, multivariable regression models between each subscale and substance-use showed that higher H/NT, IMP, and SS scores were associated with increased risk in experimenting and greater frequency of current use: SS was related to all outcomes except frequency of drunkenness; IMP to all outcomes except alcohol experimentation; and whereas H/NT was consistently associated with greater odds for experimentation, it was associated only with the frequency of current tobacco and cannabis use. Finally, AS scores were negatively associated with all substance use outcomes (Table 5) except for alcohol experimentation. No significant interaction was detected between age and SURPS scores, whereas significant interactions between gender and IMP, H/NT and AS scores were found. Specifically, we found significant interactions between gender and IMP for tobacco experimentation, gender and H/NT for alcohol and drunkenness experimentation, and finally gender and AS for current frequency of cannabis use (see Table 5 for odds ratio and rates ratio).

4. DISCUSSION

The present results, derived from the 2011 European School Survey Project on Alcohol and Other Drugs (ESPAD)-France dataset, further support the cross-cultural validity of the

SURPS. Our findings suggest that potential interactions between these personality traits and other risk factors on patterns of drug use may have been under-investigated up to now. They are consistent notably with the concern expressed by Castellanos-Ryan and Conrod (2012) (2012) that gender differences are an issue of particular relevance in the understanding of mechanisms linking personality and substance (mis)use.

The present findings support strong measurement invariance across age groups ranging from mid-adolescence (14-15 years) to early adulthood (18-20 years). To our knowledge, the only other study on this topic concluded to partial longitudinal measurement invariance over one year during mid-adolescence (Krank et al., 2011). Altogether, these results support the robustness of the SURPS psychometric properties, thus providing evidence that SURPS score comparisons through adolescence are meaningful. In addition, latent factor mean variance and the strength of relationships among the factors (covariance) did not vary substantially across age groups (see (Jurk et al., 2015) for potential cultural differences). Finally, the absence of significant interaction indicates that the relationships between these personality traits and substance outcomes do not statistically vary with age. Importantly, the absence of any significant AS x age interaction may contradicts the hypothesis that AS progressively becomes a risk factor for substance use in the course of the transition from adolescence to young adulthood. This hypothesis stemmed notably from studies in which the use of multiple drugs of abuse was assessed and that reported strong associations between AS scores and sedative drug use in adults [e.g., with alcohol and anxiolytic use, (Conrod et al., 2000) but more modest associations between AS scores and sedative drug use in adolescents (e.g., anxiolytic and analgesic use (Woicik et al., 2009)]. Such indicators of substance use were not part of our measures, which prevents us to conclude that AS does not progressively become a risk factor for substance misuse in general. In the present study, and in line with certain conceptualizations whereby anxiety could be a strong motivator of avoidance behaviours (e.g., DeMartini and Carey, 2011), we observed that the higher the AS scores the lower the risk for tobacco and cannabis experimentation and for alcohol, tobacco and cannabis use. This replicates some previous studies (see Table 1). Hence, our approach, which consisted in analyses of measurement and structural invariance as well as analyses of interaction terms rather than sub-group comparisons, established the stability of i) these personality profiles and ii) the relationships between these personality profiles and substance use behaviours (at least for non-pharmaceutical drugs) over a developmental period ranging from mid adolescence to early adulthood.

We also confirmed previous results on the overall measurement invariance across gender of this instrument (Woicik et al., 2009; Memetovic et al., 2014; Jurk et al., 2015), despite a slight differential acquiescing response styles affecting two items (item 2 IMP scale; item 12 SS scale). Significant differences between girls and boys were observed for the mean levels of the four personality traits. As found in the previous validation study of the French version of the SURPS in a Quebec sample of 15 years old adolescents (Castonguay-Jolin et al., 2013), girls endorsed higher H/NT and AS scores but lower SS scores than boys. More generally, these gender differences for AS and SS scores appear somewhat transcultural as they are consistent with studies conducted among North American (Woicik et al., 2009; Castonguay-Jolin et al., 2013), Chinese (Siu, 2011), European (Malmberg et al., 2010; Jurk et al., 2015) or Australian and Korean (Saliba et al., 2014) samples, even though the magnitude of the mean level difference for SS scores may vary across countries (Saliba et al., 2014; Jurk et al., 2015). With respect to the first series of studies on the SURPS that were conducted across a similar age range to that of the current study but in North America (Woicik et al., 2009; see Table 1), contrasting findings were observed for H/NT scores in this series of studies: there was no gender difference in the older U.S (mean age 19.3, N=390) sample, whereas boys reported higher H/NT scores than girls in the younger Canadian (mean age 15.7, N=4234) sample.

Woicik et al. argued that this effect was consistent with previous research demonstrating that at earlier ages boys report greater depression than girls, an effect that with age is reversed (Woicik et al., 2009, p.1051). In our sample, gender differences on H/NT were statistically significant whatever the age group (data available on request from the authors), which does not support this suggestion. Another possible explanation for the inconsistency between our results (higher H/NT scores among girls than boys) and those observed by Woicik et al. ((2009) in their Canadian sample (higher H/NT scores among boys than girls) could be the impact of cultural/language differences. Nevertheless, our results are consistent with those of the Dutch validation study (Malmberg et al., 2010) as well as with those of the validation study of the French version of the SURPS among Canadian French speaking adolescents (Castonguay-Jolin et al., 2013). Still, because at least two H/NT items were shown to be differently interpreted across languages (Jurk et al., 2015), it remains unclear to what extent the various findings on gender effects for H/NT scores may be best explained by age, or culture or language. In the same way, in our study, girls also scored higher on the IMP scale. Importantly, this was the case whether or not the item that did not exhibit scalar invariance was used in IMP score calculation. This gender effect for IMP contrasts with previous findings, including those of Woicik et al. (2009) and Castonguay-Jolin et al. (2013), in which boys and girls endorsed similar IMP scores. It would be interesting to explore in other studies whether our finding reflects a culturally based personality difference [e.g., 5 of the IMP items were shown to be differently interpreted across languages in the Jurk et al. study (2015)] or related to the larger statistical power of our study. Indeed, though significant, the magnitude of the mean IMP scores difference was tiny compared to the range of individual differences found within each gender, a finding that is in line with a recent review highlighting that gender differences in general measures of impulsivity and reward sensitivity are extremely small, with strength and direction depending on the instrument used and cultures (Cross et al., 2011). In the light of recent findings showing that the magnitude of the gender differences observed varied in adolescents from different countries (Saliba et al., 2014; Jurk et al., 2015), further cross-cultural validations of the SURPS should be conducted.

Unlike the observations for age, significant interactions between gender and SURPS subscales scores were found, pointing to gender differences in these personality risk factors for drug use. Indeed, whereas it has been proposed that, irrespective of gender, individuals with a high propensity for experiencing negative affectivity are more prone to drug use – especially alcohol misuse - to alleviate their distress (see Cooper, 1994; Conrod et al., 2000), our study suggests a more complex pattern of association. Here, high levels of H/NT increased the risk of both initiating (experimentation) and maintaining (current frequency) the consumption of tobacco and cannabis, independently from gender. Conversely, regarding alcohol use and drunkenness, different patterns were observed across genders: H/NT scores predicted neither experimentation nor current frequency of drinking outcomes in boys, whereas higher H/NT scores increased the risk for experimentation of alcohol and drunkenness in girls (but not the risk for current outcomes). In addition, beyond the confirmation that the propensity for novelty/sensation seeking and disinhibition/impulsivity maybe critically involved in early substance misuse (Tarter et al., 2004; Krank et al., 2011; Castellanos-Ryan and Conrod, 2012), we found that gender influences some of these associations. Indeed, IMP scores predicted all our outcomes except alcohol experimentation (but see Malmberg et al., 2010 for a significant effect), and we were further able to show that the relationship between IMP and tobacco experimentation was stronger for girls than boys. Finally, the AS protective effect for cannabis consumption appeared among girls only. In line with the findings that motives for drug use are important mediators between personality traits and substance-related outcomes, and that these mediational relationships are gender-specific (e.g., Lammers et al., 2013), further research testing such mediational models could be conducted on the ESPAD sample.

While one of the main strengths of our study is the large representative sample including students from all relevant school types and from all French geographical regions, this study also has some limitations. The main one is that the cross-sectional design did not directly assess intra-individual substance use changes over time and thus does not enable prospective inferences to be drawn. Future research is needed to examine the mediational effects of age and gender using a longitudinal design. This is of particular concern for IMP and SS findings, since bidirectional relationships between these personality traits and alcohol and tobacco use (Malmberg et al., 2013) have been shown in early adolescence (12-13 years). In addition, the measure we used for the frequency of drug use (items of the European School Survey Project on Alcohol and Drugs instrument, ESPAD) does not represent quantity assessment (i.e., it estimates the number of occasion in the last 30 days but not the amount of consumption per occasion), so may not be optimal to establish precise patterns of substance misuse in adolescent samples. Other limitations concern potential measurement errors common to all questionnaire surveys based on self-reports, such as social desirability response bias and memory bias. To optimize measurement validity, full confidentiality (anonymity) was guaranteed. Finally, given that school-based surveys are subject to coverage errors, the generalizability of our findings is questionable, since substance use rates have been shown to be higher among adolescents whose school attendance is irregular (Chou et al., 2006).

Despite these limitations, and although there is still a need to examine potential mediators of the associations observed, (including individual factors such as motives (Chandley et al., 2014; Mushquash et al., 2014; Loxton et al., 2015), and environmental factors, notably parental practices (Raboteg-Sarić et al., 2001; Sitnick et al., 2014; Finan et al., 2015), the present results provide important information on some factors that should be taken into account in tailoring new prevention and intervention approaches in France as elsewhere (Conrod et al., 2013).

Role of funding source: Nothing to declare

Contributors: SS, CH, CB and SB designed and performed the study. AA, AC, CB, and SB conducted the literature searches. AA, CH, AV and CB undertook the statistical analyses. AA, CB, AC and SB wrote the first draft of the manuscript. All authors significantly participated in interpreting the results and revising the manuscript.

Conflicts of interest: None

Acknowledgements

Thanks are due to the ministry of Education and all the parent-teacher association. The French Observatory for Drugs and Addiction (OFDT) supported this survey. We also thank all the parents and of course all the French adolescents who completed this survey.

REFERENCES

Batel, P., 2000. Addiction and schizophrenia. Eur. Psychiatry J. Assoc. Eur. Psychiatr. 15, 115–122.

Bender, Lange, 2001. Adjusting for multiple testing--when and how? J. Clin. Epidemiol. 54, 343–349.

Canfield, M., Gilvarry, C., Koller, S.H., 2015. Psychometric Proprities of the Substance Use Risk Profile Scale - Brazilian Version. Int. J. Ment. Health Addict. 13, 204–214. doi:http://doi.org/10.1007/s11469-014-9522-1

Castellanos-Ryan, N., Conrod, P., 2012. Personality and Substance Misuse: Evidence for a Four-Factor Model of Vulnerability. In: Verster, J., Brady, K., Galanter, M., Conrod, P. (Eds.), Drug Abuse and Addiction in Medical Illness. Springer, New York, pp. 47–62.

Castellanos-Ryan, N., O'Leary-Barrett, M., Sully, L., Conrod, P., 2013. Sensitivity and specificity of a brief personality screening instrument in predicting future substance use, emotional, and behavioral problems: 18-month predictive validity of the Substance Use Risk Profile Scale. Alcohol. Clin. Exp. Res. 37 Suppl. 1, E281–290. doi:http://doi.org/10.1111/j.1530-0277.2012.01931.x

Castonguay-Jolin, L., Perrier-Ménard, E., Castellanos-Ryan, N., Parent, S., Vitaro, F., Tremblay, R.E., Garel, P., Séguin, J.R., Conrod, P.J., 2013. [SURPS French version validation in a Quebec adolescent population]. Can. J. Psychiatry Rev. Can. Psychiatr. 58, 538–545.

Chambers, R.., Taylor, J.., Potenza, M.., 2003. Developmental neurocircuitry of motivation in adolescence: a critical period of addiction vulnerability. Am. J. Psychiatry 58, 538–545.

Chandley, R.B., Luebbe, A.M., Messman-Moore, T.L., Ward, R.M., 2014. Anxiety sensitivity, coping motives, emotion dysregulation, and alcohol-related outcomes in college women: a moderated-mediation model. J. Stud. Alcohol Drugs 75, 83–92.

Chen, F., 2007. Sensitivity of Goodness of Fit Indexes to Lack of Measurement Invariance. Struct. Equ. Model. Multidiscip. J. 14, 464–504.

doi:http://doi.org/10.1080/10705510701301834

Cheung, G.., Rensvold, R.B., 1999. Testing factorial invariance across groups: a reconceptualization and proposed new method. J. Manage 25–27.

Cheung, G.W., Rensvold, R.B., 2002. Evaluating goodness-of-fit indexes for testing measurement invariance. Struct. Equat. Model. 9, 233- 255.

Chou, L., Ho, C., Chen, W., 2006. Truancy and illicit drug use among adolescents surveyed via street outreach. Addict. Behav. 31, 149–154.

Conrod, P.J., O'Leary-Barrett, M., Newton, N., Topper, L., Castellanos-Ryan, N., Mackie, C., Girard, A., 2013. Effectiveness of a selective, personality-targeted prevention program for adolescent alcohol use and misuse a cluster randomized controlled trial. JAMA Psychiatry 70, 334–342. doi:http://doi.org/10.1001/jamapsychiatry.2013.651

Conrod, P.J., Pihl, R.O., Stewart, S.H., Dongier, M., 2000. Validation of a system of classifying female substance abusers on the basis of personality and motivational risk factors for substance abuse. Psychol. Addict. Behav. 14, 243–256.

Cooper, 1994. Motivations for alcohol use among adolescents: development and validation of a four-factor model. Psychol. Assess. 6, 117–128.

Cox, W.., Kingler, E., 1988. A motivational model of alcohol use. J. Abnorm. Child Psychol. 97, 168–180.

Cross, C., Copping, L., Campbell, A., 2011. Sex differences in impulsivity: a meta-analysis. Psychol. Bull. 137, 97–130. doi:http://doi.org/10.1037/a0021591.

DeMartini, K.S., Carey, K.B., 2011. The role of anxiety sensitivity and drinking motives in predicting alcohol use: a critical review. Clin. Psychol. Rev. 31, 169–177. doi:http://dx.doi.org/10.1016/j.cpr.2010.10.001

Ersche, K.., Turton, A.., Chamberlain, S.., Müller, U., Bullmore, E.., Robbins, T.W., 2012. Cognitive dysfunction and anxious-impulsive personality traits are endophenotypes for drug dependence. Am. J. Psychiatry 169, 926–936. doi:http://dx.doi.org/10.1176/appi.ajp.2012.11091421

Finan, L.J., Schulz, J., Gordon, M.S., Ohannessian, C.M., 2015. Parental problem drinking and adolescent externalizing behaviors: the mediating role of family functioning. J. Adolesc. 43, 100–110. doi:http://dx.doi.org/10.1016/j.adolescence.2015.05.001

Gregorich, S.E., 2006. Do self-report instruments allow meaningful comparisons across diverse population groups? Testing measurement invariance using the confirmatory factor analysis framework. Med. Care 44, S78–94. doi:http://dx.doi.org/10.1097/01.mlr.0000245454.12228.8f

Hibell, B., Guttormsson, U., Ahlström, S. Balakireva, O., Bjarnason ,T., Kokkevi, A., Kraus, L., 2012. The 2011 ESPAD Report Substance Use Among Students in 36 European Countries. CAN, Stockholm.

Hustad, J.T.P., Pearson, M.R., Neighbors, C., Borsari, B., 2014. The role of alcohol perceptions as mediators between personality and alcohol-related outcomes among incoming college-student drinkers. Psychol. Addict. Behav. J. Soc. Psychol. Addict. Behav. 28, 336–347. doi:http://dx.doi.org/10.1037/a0033785

Jurk, S., Kuitunen-Paul, S., Kroemer, N.B., Artiges, E., Banaschewski, T., Bokde, A.L.W., Büchel, C., Conrod, P.J., Fauth-Bühler, M., Flor, H., Frouin, V., Gallinat, J., Garavan, H., Heinz, A., Mann, K., Nees, F., Paus, T., Pausova, Z., Poustka, L., Rietschel, M., Schumann, G., Struve, M., Smolka, M.N., IMAGEN Consortium, 2015. Personality and substance use: psychometric evaluation and validation of the Substance Use Risk Profile Scale (SURPS) in English, Irish, French, and German adolescents. Alcohol. Clin. Exp. Res. doi:http://dx.doi.org/10.1111/acer.12886

Krank, M., Stewart, S.H., O'Connor, R., Woicik, P.B., Wall, A.-M., Conrod, P.J., 2011. Structural, concurrent, and predictive validity of the Substance Use Risk Profile Scale in early adolescence. Addict. Behav. 36, 37–46. doi:http://dx.doi.org/10.1016/j.addbeh.2010.08.010

Kuhn, C., 2015. Emergence of sex differences in the development of substance use and abuse during adolescence. Pharmacol. Ther. 153, 55–78. doi:http://dx.doi.org/10.1016/j.pharmthera.2015.06.003.

Lammers, J., Kuntsche, E., Engels, R.C.M.E., Wiers, R.W., Kleinjan, M., 2013. Mediational relations of substance use risk profiles, alcohol-related outcomes, and drinking motives among young adolescents in the Netherlands. Drug Alcohol Depend. 133, 571–579. doi:http://dx.doi.org/10.1016/j.drugalcdep.2013.07.030

Loxton, N.J., Bunker, R.J., Dingle, G.A., Wong, V., 2015. Drinking not thinking: a prospective study of personality traits and drinking motives on alcohol consumption across the first year of university. Pers. Individ. Diff. 79, 134–139. doi:http://dx.doi.org/10.1016/j.paid.2015.02.010

Malmberg, M., Kleinjan, M., Overbeek, G., Vermulst, A.A., Lammers, J., Engels, R.C.M.E., 2013. Are there reciprocal relationships between substance use risk personality profiles and alcohol or tobacco use in early adolescence? Addict. Behav. 38, 2851–2859. doi:http://dx.doi.org/10.1016/addbeh.2013.08.003

Malmberg, M., Overbeek, G., Monshouwer, K., Lammers, J., Vollebergh, W.A.M., Engels, R.C.M.E., 2010. Substance use risk profiles and associations with early substance use in adolescence. J. Behav. Med. 33, 474–485. doi:http://dx.doi.org/10.1007/s10865-010-9278-4

Marsh, H.., Nagengast, B., Morin, A.J.., 2013. Measurement invariance of big-five factors over the life span: ESEM tests of gender, age, plasticity, maturity, and la dolce vita effects. Dev. Psychol. 49, 1194–1218. doi:http://doi.org/10.1037/a0026913

Memetovic, J., Ratner, P.A., Richardson, C.G., 2014. Gender-based measurement invariance of the substance use risk profile scale. Addict. Behav. 39, 690–694. doi:http://dx.doi.org/10.1016/j.addbeh.2013.10.016

Meredith, W., Teresi, J.A., 2006. An essay on measurement and factorial invariance. Med. Care 44, S69–77. doi:http://dx.doi.org/10.1097/01.mlr.0000245438.73837.89

Mushquash, C.J., Stewart, S.H., Mushquash, A.R., Comeau, M.N., McGrath, P.J., 2014. Personality traits and drinking motives predict alcohol misuse among Canadian Aboriginal youth. Int. J. Ment. Health Addict. 12, 270–282. doi:10.1007/s11469-013-9451-4

Omiya, S., Kobori, O., Tomoto, A., Igarashi, Y., Iyo, M., 2015. Personality and substance use in Japanese adolescents: the Japanese version of Substance Use Risk Profile Scale. Personal. Individ. Differ. 76, 153–157. doi:http://dx.doi.org/10.1016/j.paid.2014.11.034

Peeters, M., Monshouwer, K., van de Schoot, R., Janssen, T., Vollebergh, W.A.M., Wiers, R.W., 2014. Personality and the prediction of high-risk trajectories of alcohol use during adolescence. J. Stud. Alcohol Drugs 75, 790–798.

Raboteg-Šarić, Z., Rijavec, M., Brajsa-Zganec, A., 2001. The relation of parental practices and self-conceptions to young adolescent problem behaviors and substance use. Nord. J. Psychiatry 55, 203–209. doi:http://dx.doi.org/10.1080/08039480152036092

Richardson, C., Memetovic, J., Ratner, P., Johnson, J., 2011. Examining gender differences in emerging tobacco use using the Adolescents' Need For Smoking Scale. Addiction 1846–1854. doi:10.1111/j.1360-0443.2011.03496.x. Epub 2011 Aug 9

Robles-García, R., Fresán, A., Castellanos-Ryan, N., Conrod, P., Gómez, D., de Quevedo Y Domínguez, M.E.G., Rafful, C., Real, T., Vásquez, L., Medina-Mora, M.E., 2014. Spanish version of the Substance Use Risk Profile Scale: factor structure, reliability, and validity in Mexican adolescents. Psychiatry Res. 220, 1113–1117. doi:10.1016/j.psychres.2014.08.057

Rosseel, Y., 2012. lavaan: an R Package for Structural Equation Modeling. J. Stat. Softw. 48, 1–36.

Saliba, A.J., Moran, C., Yoo, Y., 2014. The Substance Use Risk Profile Scale: comparison of norms and outcomes for Australian and Korean adults. Int. J. Ment. Health Addict. 12, 538–547. doi:http://dx.doi.org/10.1007/s11469-014-9490-5

Schlauch, R.C., Crane, C.A., Houston, R.J., Molnar, D.S., Schlienz, N.J., Lang, A.R., 2015. Psychometric Evaluation of the Substance Use Risk Profile Scale (SURPS) in an inpatient sample of substance users using cue-reactivity methodology. J. Psychopathol. Behav. Assess. 37, 231–246. doi:10.1007/s10862-014-9462-x

Sitnick, S.L., Shaw, D.S., Hyde, L.W., 2014. Precursors of adolescent substance use from early childhood and early adolescence: testing a developmental cascade model. Dev. Psychopathol. 26, 125–140. doi:http://dx.doi.org/10.1017/S0954579413000539

Siu, A.F.Y., 2011. Validation of the Substance Use Risk Profile Scale for adolescents in Hong Kong. J. Psychoeduc. Assess. 29, 75–83. doi:10.1177/0734282910362044

Spilka, S., Le Nézet, O., 2013. Alcool, tabac et cannabis durant des «années lycée». Tendances 89.

Tarter, R.E., Kirisci, L., HabeychM., Reynolds, M., Vanyukov, M., 2004. Neurobehaviour disinhibition in childhood predisposes boys to substance use disorder by young adulthood: direct and mediated etiologic pathways. Drug Alcohol Depend. 73, 121–132.

WHO, 2012. Social Determinants Of Health And Well-Being Among Young People. Health Behaviour in School-aged Children (HBSC) study. WHO, Geneva.

Woicik, P.A., Stewart, S.H., Pihl, R.O., Conrod, P.J., 2009. The Substance Use Risk Profile Scale: a scale measuring traits linked to reinforcement-specific substance use profiles. Addict. Behav. 34, 1042–1055. doi:http://dx.doi.org/10.1016/j.addbeh.2009.07.001

Tables

Table 1: Key findings of validation studies assessing SURPS predictive validity with substance use

Population					Analyses	AS				H/NT				IMP				SS			
1st Author (year)	N	Setting/ language	% male	Age	Design	A	EA	T	C	A	EA	T	C	A	EA	T	C	A	EA	T	C
Malmberg 2010	3783	NL nl	49	13.0 (.5)	CS/bc [e]	↓	.	~	~	↑		↑	↑	↑	.	↑	↑	↑	.	↑	↑
Malmberg 2012	758	NL nl	47	12.9 (.4)	PR/bc [e]	~	.	~	~	↑		↑	~	↑	.	~	~	↑	.	↑	↑
Krank 2011 w2[a]	1139	CA en	55	14-16	CS/rm [f]	↓	↓	~	~	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Krank 2011 w2, w3[a]					PR/rm [f]	~	~	~	~	↑	~	↑	↑	↑	~	↑	~	~	↑	↑	↑
Castellanos 2013	1162	UK en	58	13.7	CS/rm [f]	↓	~	~	↓	~	~	↑	↑	↑	↑	↑	↑	~	~	~	~
					PR/rm [g]	~	~	~	~	~	~	↑	↑	↑	↑	↑	↑	~	~	~	↑
Woicik 2009 s2[b]	390	US en	45	19.3 (3.1)	CS/bc [h]	↓	.	~	↓	~	.	~	~	~	.	↑	~	↑	.	~	↑
Woicik 2009 s3[b]	4234	CA en	48	15.7 (1)	CS/bc [h]	~	~	.	.	↑	↑	.	.	↑	↑	.	.	↑	↑	.	.
Malmberg 2013	1068	NL nl	47	12.9 (.4)	CS/bc [h]	↓	~	~	.	↑	↑	↑	.	↑	~	↑	.	↑	↑	↑	
Castonguay 2013	202	CA fr	48	15	CS/bc [h]	↑	~	.	.	~	~	.	.	↑	↑	.	.	↑	↑	.	.
Schlauch 2015 [c]	175	US en	68	41.6 (11.2)	CS/rm [i]	↑	.	↑	-	↑	.	-	-	- ~		-	↑	~	.	-	-
Jurk 2015	2022	EU [d]	49	14.4 (0.4)	PR/bc [j]	↓	↓		~	↑	~		↑	↑	↑		↑	↑	↑		↑
Jurk 2015					PR/rm [k]	~	~	~	~	~	~	~	~	~	~	↑	↑	↑	↑	↑	↑

A : Alcohol; EA : binge drinking/heavy use; T : Tobacco ; C : Cannabis.

Age = mean (SD) unless otherwise stated; CS = cross-sectional, PR = prospective, BC = Bivariate correlations, RM= regression models;

↑ : positive association, ↓ negative association, ~ non-significant association, “.” not tested

[a] w2, w3 : Wave 2 and Wave 3 ; [b] s2, s3 : sample 2 and sample 3 of the study ; [c] inpatient substance abuse treatment program ; [d] de (N=987), en (N=786), fr (N=249). Substance use outcomes:

[e] Experimentation (Lifetime prevalence dichotomously scored as yes/no)

[f] Current use (dichotomously scored as yes/no)

[g] EA and Cannabis: Current use (dichotomously scored as yes/no) ; Alcohol and tobacco : Frequency of current use

[h] Frequency score

[i] Tobacco and Cannabis: Frequency of current use; Alcohol: Alcohol quantity per occasion

[j] Frequency of current use at follow-up (mean age at follow-up 16.5 years)

[k] Substance use at follow-up for persons not using these substances at baseline (mean age at baseline 14.4 years)

Table 2: Substance use according to Gender and Age

	Gender					Age							All	
	Female n=2738		Male n=2331		p [c]	14-15 years n=1001		16-17 years n=2903		18-20 years n=1165		p [c]	n=5069	
Experimentation rates [a]														
Alcohol	2494	(91.2%)	2160	(93.0%)	*	929	(93.0%)	2654	(91.6%)	1071	(92.0%)		4654	(92.0%)
Drunkenness	1517	(55.4%)	1394	(59.8%)	**	460	(46.0%)	1682	(58.0%)	769	(66.1%)	***	2911	(57.5%)
Tobacco	1922	(70.2%)	1530	(65.7%)	***	570	(56.9%)	2033	(70.0%)	849	(73.0%)	***	3452	(68.1%)
Cannabis	1194	(43.6%)	1131	(48.8%)	***	349	(35.0%)	1353	(46.8%)	623	(53.5%)	***	2325	(46.0%)
Current frequency [b]														
Alcohol	3.71	(5.93)	7. 42	(10.39)	***	3.62	(6.48)	5.57	(8.56)	6.68	(9.59)	***	5.43	(8.51)
Drunkenness	0.63	(1.60)	1.00	(2.24)	***	0.62	(1.58)	0.83	(1.97)	0.86	(2.07)	*	0.81	(1.94)
Tobacco (cigarettes/day)	3.41	(5.16)	3.58	(5.42)		2.52	(4.61)	3.37	(5.05)	4.40	(6.04)	***	3.48	(5.28)
Cannabis	2.77	(6.57)	5.94	(11.02)	***	3.60	(7.59)	4.56	(9.34)	4.17	(9.52)	***	4.31	(9.15)

Note: Data are mean (SD) or numbers (%).

[a] On at least one occasion in lifetime.

[b] Represents the mean frequency during the last month among those who reported lifetime experimentation (*e.g.* for the frequency of current alcohol use, only those who have drunk alcohol at some time in their lives). Alcohol, drunkenness and cannabis: mean number of occasions during the past month; Tobacco: mean number of cigarettes per day.

[c] Outcomes were compared by gender or by age classes using chi-square test, 2-sample Student t test, or the Wilcoxon rank sum test, as appropriate. Significance level: *** $p < .001$, p **< .01, * p <.05.

Table 3: Test for measurement and structural invariance of the four-factor model across Gender, Age.

Models	Chi	df	CFI	RMSEA	Delta CFI	Delta RMSEA
Unconstrained model	1498.603	158	0.926	0.041		
Gender (F,M)						
G1. Configural Invariance	1717.394	316	0.921	0.042		
G2. Full Metric Invariance	1788.433	336	0.918	0.041	-0.003	-0.001
G3b Partial strong Factorial Invariance [a]	1906.534	350	0.912	0.042	-0.005 [b]	+ 0.001 [b]
G4b. Partial strict Factorial Invariance [a]	1993.112	370	0.909	0.042	-0.003	0.000
G5b. Structural Invariance [a]	*2384.051*	*380*	*0.887*	*0.046*	*-0.022*	*+ 0.004*
G1. Configural Invariance	1717.394	316	0.921	0.042		
G2. Full Metric Invariance	1788.433	336	0.918	0.041	-0.003	-0.001
G3. Full Strong Factorial Invariance	2037.778	352	0.905	0.043	-0.013	+ 0.002
G4. Full Strict Factorial Invariance	2124.714	372	0.901	0.043	-0.004	0.000
G5. Structural Invariance	*2544.983*	*382*	*0.878*	*0.047*	*-0.023*	*+ 0.004*
Age ([14-15],[16-17],[18-20])						
A1. Configural Invariance	1812.202	474	0.927	0.041		
A2. Full Metric Invariance	1849.657	514	0.927	0.039	0.000	-0.002
A3. Full Strong Factorial Invariance	1908.173	546	0.925	0.038	-0.002	-0.001
A4. Full Strict Factorial Invariance	1984.824	586	0.923	0.038	-0.002	0.000
A5. Structural Invariance	2023.395	606	0.922	0.037	-0.001	-0.001

Note: CFI, comparative fit index; RMSEA, root mean square error of approximation.

Configural invariance (same factorial structures are specified for each sample, and no equality constraints are imposed on the intercepts, factor loadings, and residual variances across groups); metric invariance (equal factor loadings across groups); strong invariance (equal factor loadings and intercepts); strict invariance (equal factor loadings, intercepts and item residual variances); and structural invariance (additional constraints on latent means and variance-covariance). Delta-values represent differences in the respective parameters compared with the parameters from the preceding model.

[a] Intercepts for items 2 and 12 free to vary across gender

Table 4: SURPS Subscale means, standard deviations according to gender and Intercorrelations (Pearson coefficients) linking the four SURPS scores

	Girls				Boys			
	H/NT	AS	IMP	SS	H/NT	AS	IMP	SS
mean [a]	2.01	2.63	2.43	2.64	1.89	2.37	2.34	2.89
SD	0.52	0.52	0.55	0.70	0.52	0.57	0.58	0.65
Interscale correlations								
H/NT		.03	.16***	- .03		.07**	.10***	- .22***
AS		-	.12***	- .04*		-	.25***	.04*
IMP			-	.23***			-	.28***

Notes: SD, standard deviation; H/NT, hopelessness/negative thinking; AS, anxiety sensitivity; IMP, impulsivity; SS, Sensation seeking

[a] Subscale scores maintained the range of the individual items (1-5) by calculating the average score for each item on the subscale.

Significance level: *** p < .001, p **< .01, * p <.05

Table 5: Summary of regression analysis for personality variables predicting lifetime experimentation and substance use in the past month

	AS	H/NT	IMP	SS
Experimentation (y/n)				
Alcohol	0.92[0.75;1.12]	♂1.24[0.90;1.70] ♀2.08[1.53;2.81]***	1.17[0.95;1.44]	1.67 [1.41;1.98]***
Drunkenness	0.82[0.73;0.92]***	♂1.18[0.99;1.41] ♀1.45[1.23;1.71]***	1.59[1.42;1.79]***	1.71[1.55;1.89]***
Tobacco	0.76[0.67;0.85]***	1.48[1.30;1.69]***	♂1.26[1.07;1.49]** ♀1.69[1.43;2.01]***	1.91[1.73;2.12]***
Cannabis	0.71[0.63;0.79]***	1.51[1.34;1.70]***	1.45[1.29;1.63]***	1.81[1.64;1.99]***
Current frequency of substance use				
Alcohol	0.79[0.73;0.85]***	1.03[0.93;1.12]	1.25[1.16;1.35]***	1.23[1.15;1.32]***
Drunkenness	0.75[0.64;0.87]***	1.18[1.00;1.40]	1.19[1.04;1.40]*	1.13[0.98;1.30]
Tobacco	0.77[0.70;0.85]***	1.22[1.10;1.33]***	1.36[1.23;1.50]***	1.21[1.11;1.31]***
Cannabis	♂0.86[0.69;1.05] ♀ 0.60[0.47;0.79]*	1.30[1.09;1.55]**	1.22[1.01;1.43]*	1.32[1.15;1.56]***

Note: The values (Odds ratio and Rate ratio, 95%CI and significance level *** $p < .001$, ** $p < .01$, * $p < .05$) under the subscales show the magnitude of the contribution of that subscale according to multiple logistic regression models for experimentation and multiple quasi-Poisson regression models for frequency of substance use in the past month. Odds/Rate ratios show unique effects of personality traits, as all 4 subscales are entered into each model. Values significantly above 1 indicate an increased risk of substance use, values significantly below 1 indicate a decreased risk of substance use.