Journal of Public Health

Predictive utility of the NEO-FFI for later substance experiences among 16-year-old adolescents

--Manuscript Draft--

Manuscript Number:	JOPH-D-16-00112R2
Full Title:	Predictive utility of the NEO-FFI for later substance experiences among 16-year-old adolescents
Article Type:	Original Article
Corresponding Author:	Caroline Parchetka Charite Universitatsmedizin Berlin GERMANY
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	Charite Universitatsmedizin Berlin
Corresponding Author's Secondary Institution:	
First Author:	Caroline Parchetka
First Author Secondary Information:	
Order of Authors:	Caroline Parchetka
	Nicole Strache
	Bianca Raffaelli
	Isabel Gemmeke
	Katharina Weiss
	Eric Artiges
	Tobias Banaschewski
	Arun Bokde
	Uli Bromberg
	Christian Buechel
	Patricia Conrod
	Sylvane Desrivières
	Herta Flor
	Vincent Frouin
	Hugh Garavan
	Penny Gowland
	Andreas Heinz
	Bernd Ittermann
	Herve Lemaitre
	Jean-Luc Martinot
	Eva Mennigen
	Frauke Nees
	Marie-Laure Paillère Martinot

	Dimitri Papadopoulos
	Tomáš Paus
	Luise Poustka
	Sarah Jurk
	Michael N Smolka
	Nora C Vetter
	Henrik Walter
	Robert Whelan
	Gunter Schumann
	Juergen Gallinat
Order of Authors Secondary Information:	
Funding Information:	

Abstract:

Purpose: The onset of substance use mostly occurs during adolescence. The aim of the present study is to investigate the relevance of personality on the basis of the NEO-Five-Factor-Inventory (NEO-FFI) to future experiences with tobacco, alcohol and cannabis.

Methods: The test data were derived from the baseline assessment and first follow-up of the IMAGEN study, a European multicenter and multidisciplinary research project on adolescent mental health. In the present study 1004 participants were tested. The characterization of personality was conducted with the NEO-FFI at the age of 14 (T1). The data on substance use were collected with the European School Survey Project on Alcohol and Other Drugs (ESPAD) questionnaire at the age of 16 (T2). For the statistical analysis, t-tests and univariate analyses of variance were performed.

Results: The scores of Conscientiousness at T1 were significantly lower for adolescents with tobacco, alcohol and cannabis experiences at T2. We found lower scores of Agreeableness at T1 in participants with tobacco and cannabis use at T2. Extraversion at T1 was significantly higher for adolescents with smoking experiences at T2. No significant associations between Neuroticism or Openness and future substance use were observed.

Conclusion: Low scores of Conscientiousness and Agreeableness seem to have the greatest value for a prediction of later experiences with substance use. As the present study is the first one to examine the predictive value of the NEO-FFI for future substance use in an adolescent sample, further studies are necessary to enable a better applicability in a clinical context.

Response to Reviewers:

We thank for the helpful comments and hope that we have addressed all points raised by the reviewer.

References
*   References have not been made according to guidelines for authors. (Please refer to http://www.springer.com/medicine/health+informatics/journal/10389)
*   List of References should only include works that are cited in the text.
*   Please add access dates for all online sources respecting our formal guidelines for online sources.
*   Reduce number of quotations (* max. 30 in original works, * max. 50 in overviews)
*   References are not in alphabetic order.
*   References should not be numbered.
*   Please use Index Medicus for abbreviations of the journal title.
*   Please delete the full stop sign after each reference in your reference list.
*   Please name all authors, e.g. do not abbreviate using et al.
The list of References should only include works that are cited in the text and that have been published or accepted for publication. Personal communications should only be mentioned in the text. In the text, references should be cited by author and year (e.g.

Hammer 1994; Hammer and Sjöqvist 1995; Hammer et al. 1993) and listed in alphabetical order in the reference list. Here are some examples:
Journals
Algenstaedt P, Windler E, Peiper M, Busch C,Bucheler E, Greten H (1994) Localized fibrous pleural mesothelioma: value of image-producing methods for the differentiation from supradiaphragmatic tumors of the liver. Dtsch Med Wochenschr 119:296-300
Bernard SA, Buist M (2003) Induced hypothermia in critical care medicine: a review. Crit Care Med 31:2041-2051
Books
Happyman A (1985) Pleural neoplasms. In: Studious B (ed) Textbook on carcinoma, 2nd edn. Springer, Berlin Heidelberg New York, pp 542-550
Charles C (2001) Scientific innovation. Wiley, New York.
Where available, the Digital Object Identifier (DOI) of the cited literature should be added at the end of the reference in question.
Ward J, Robinson PJ (2002) How to detect hepatocellular carcinoma in cirrhosis. Eur Radiol 12:2258-2272. DOI 10.1007/s00330-002-1450-y

We referred to guidelines for authors (http://www.springer.com/medicine/health+informatics/journal/10389). Only references that were cited in the text are included. Number of references is reduced to 27 references and listed in alphabetical order. We deleted the full stop sign after each reference and named all authors avoiding using et al.

Citation
Cite references in the text by name and year in parentheses. Some examples:
*   Negotiation research spans many disciplines (Thompson 1990).
*   This result was later contradicted by Becker and Seligman (1996).
*   This effect has been widely studied (Abbott 1991; Barakat et al. 1995; Kelso and Smith 1998; Medvec et al. 1999).

We changed the citation style according to the guidelines for authors. Now we cite references by name and year in parentheses.

This concludes the list of all suggestions, and of how we reacted to each of them.
We would be pleased if the reviewer sees our revision as a serious effort to incorporate the points raised and as an improvement of our manuscript.

Contributers

Caroline Parchetka[1]; Nicole Strache[1]; Bianca Raffaelli[1]; Isabel Gemmeke[1]; Katharina Weiß[1]; Eric Artiges[2]; Tobias Banaschewski[3]; Arun Bokde[4]; Uli Bromberg[5]; Christian Buechel[5]; Patricia Conrod[6,8]; Sylvane Desrivières[6]; Herta Flor[9]; Vincent Frouin[10]; Hugh Garavan[11]; Penny Gowland[12]; Andreas Heinz[1]; Bernd Ittermann[13]; Herve Lemaitre[14], Jean-Luc Martinot[15]; Eva Mennigen[16]; Frauke Nees[9]; Marie-Laure Paillère Martinot[17]; Dimitri Papadopoulos[10]; Tomáš Paus[18]; Luise Poustka[3]; Sarah Jurk[16]; Michael N. Smolka[16]; Nora C. Vetter[16]; Henrik Walter[1]; Rob Whelan[4]; Gunter Schumann[6,7]; Juergen Gallinat[19]*; and the IMAGEN consortium.

[1]Department of Psychiatry and Psychotherapy, Campus Charité Mitte, Charité, Universitätsmedizin Berlin, Charitéplatz 1, Berlin, Germany;

[2]INSERM, UMR 1000, Research unit Imaging and Psychiatry, CEA, DSV, I²BM-Service Hospitalier Frédéric Joliot, Orsay; University Paris-Sud 11, Orsay; University Paris Descartes, Sorbonne Paris Cité, Paris, France; and Psychiatry Department 91G16, Orsay Hospital, Orsay, France;

[3]Department of Child and Adolescent Psychiatry, Central Institute of Mental Health, Medical Faculty Mannheim, Heidelberg University, Square J5, 68159 Mannheim, Germany;

[4]Discipline of Psychiatry, School of Medicine and Trinity College Institute of Neurosciences, Trinity College Dublin;

[5]University Medical Centre Hamburg-Eppendorf, Haus S10, Martinistr. 52, Hamburg, Germany;

[6]Institute of Psychiatry, Psychology & Neuroscience, King's College London, United Kingdom;

[7]Medical Research Council – Social, Genetic and Developmental Psychiatry Centre, Institute of Psychiatry, Kings College London, De Crespigny Park, London, United Kingdom;

[8]Department of Psychiatry, Universite de Montreal, CHU Ste Justine Hospital, Canada;

[9]Department of Cognitive and Clinical Neuroscience, Central Institute of Mental Health, Medical Faculty Mannheim, Heidelberg University, Square J5, Mannheim, Germany;

[10]Neurospin, Commissariat à l'Energie Atomique, CEA-Saclay Center, Paris, France;

[11]Departments of Psychiatry and Psychology, University of Vermont, 05405 Burlington, Vermont, USA;

[12]School of Psychology, University of Nottingham, University Park, Nottingham, United Kingdom;

[13]Physikalisch-Technische Bundesanstalt (PTB), Abbestr. 2 - 12, Berlin, Germany;

[14]INSERM, UMR 1000, Research unit Imaging and Psychiatry, CEA, DSV, I²BM-Service Hospitalier Frédéric Joliot, Orsay; Faculté de médecine, Université Paris-Sud, Le Kremlin-Bicêtre; and Université Paris Descartes, Sorbonne Paris Cité, Paris, France;

[15]INSERM, UMR 1000, Research unit Imaging and Psychiatry, CEA, DSV, I²BM-Service Hospitalier Frédéric Joliot, Orsay; University Paris-Sud 11, Orsay; and University Paris Descartes, Sorbonne Paris Cité, Paris, France;

[16]Department of Psychiatry and Neuroimaging Center, Technische Universität Dresden, Dresden, Germany;

[17]INSERM, UMR 1000, Research unit Imaging and Psychiatry, CEA, DSV, I²BM-Service Hospitalier Frédéric Joliot, Orsay; University Paris-Sud 11, Orsay; University Paris Descartes, Sorbonne Paris Cité, Paris; and AP-HP, Department of Adolescent Psychopathology and Medicine, Maison de Solenn, Cochin Hospital, Paris, France;

[18]Rotman Research Institute, Baycrest and Departments of Psychology and Psychiatry, University of Toronto, Toronto, Ontario, M6A 2E1, Canada;

[19]Department of Psychiatry and Psychotherapy, University Medical Center Hamburg-Eppendorf (UKE), Martinistrasse 52, 20246 Hamburg.

*Corresponding author: Prof. Dr. Juergen Gallinat, Department of Psychiatry and Psychotherapy, University Medical Center Hamburg-Eppendorf (UKE), Martinistrasse 52, 20246 Hamburg.
Tel.: 0049 (0)40 7410 – 52 201. Fax: 0049 (0)40 7410 – 52 999. E-mail: j.gallinat@uke.de

Predictive utility of the NEO-FFI for later substance experiences among 16-year-old adolescents

Abstract

Purpose: The onset of substance use mostly occurs during adolescence. The aim of the present study is to investigate the relevance of personality on the basis of the NEO-Five-Factor-Inventory (NEO-FFI) to future experiences with tobacco, alcohol and cannabis.

Methods: The test data were derived from the baseline assessment and first follow-up of the IMAGEN study, a European multicenter and multidisciplinary research project on adolescent mental health. In the present study 1004 participants were tested. The characterization of personality was conducted with the NEO-FFI at the age of 14 (T1). The data on substance use were collected with the European School Survey Project on Alcohol and Other Drugs (ESPAD) questionnaire at the age of 16 (T2). For the statistical analysis, t-tests and univariate analyses of variance were performed.

Results: The scores of Conscientiousness at T1 were significantly lower for adolescents with tobacco, alcohol and cannabis experiences at T2. We found lower scores of Agreeableness at T1 in participants with tobacco and cannabis use at T2. Extraversion at T1 was significantly higher for adolescents with smoking experiences at T2. No significant associations between Neuroticism or Openness and future substance use were observed.

Conclusion: Low scores of Conscientiousness and Agreeableness seem to have the greatest value for a prediction of later experiences with substance use. As the present study is the first one to examine the predictive value of the NEO-FFI for future substance use in an adolescent sample, further studies are necessary to enable a better applicability in a clinical context.

Purpose

Adolescence is a time of essential experimenting during psychological, cognitive, psychic and emotional development. In the context of many studies the early onset of substance use is indicated to be one of the most important predictors for future substance use, and the development of addiction (DeWit et al. 2000; Prescott and Kendler 2001) and the future consumption of illicit drugs (Kandel and Yamaguchi 1993). The three most consumed substances in European adolescents are tobacco, alcohol and cannabis.

The early onset of tobacco consumption may lead to addiction within only few years. Serious illnesses such as bronchial carcinoma, COPD and coronary heart disease as well as structural brain deficits and impaired quality of living may result (Centers for Disease and Prevention 2008; Gallinat et al. 2006; Kuhn et al. 2012). Moreover, alcohol consumption at a young age is a main risk factor for future alcohol addiction in adulthood (Grant et al. 2006) and the development of addictions to more substances like nicotine (Dierker et al. 2013). Chronic cannabis consumption as well as leisure consumption during puberty can lead to lasting cognitive impairment (Battistella et al. 2014). Morphologic changes in the brain, for instance volume reduction of the grey matter in areas with a high number of CB1-receptors have been reported (Battistella et al. 2014). In this context volume reduction correlates to the frequency of consumption (Battistella et al. 2014). Furthermore there is evidence that suggests a connection between cannabis consumption, schizophrenia and certain genetic variants (De Sousa et al. 2013). A correlation between high consumption and onset of disorder in young age has been described (De Sousa et al. 2013).

The NEO Five-Factor-Model of personality is a well-validated hierarchical organization of personality traits using five dimensions (McCrae and John 1992). NEO is an acronym for the first three dimensions: Neuroticism (e.g. the disposition to experience distress, sadness), Extraversion (e.g. the disposition to be outgoing, sociable) and Openness (e.g. the disposition to seek new experiences, to be intellectually curious) (McCrae and John 1992). The two additional dimensions are Agreeableness (e.g. the disposition to be cooperative, compassionate) and Conscientiousness (e.g. the disposition to be self-disciplined, reliable) (McCrae and John 1992).

So far, studies suggest associations between the consumption of substances and personality (Whelan et al. 2014; Woicik et al. 2009). The NEO-Five-Factor-Model of personality is a widely used model to describe personality. Synopsis studies suggest that substance use is mainly found in participants with a high score of Neuroticism, Extraversion, Openness and low score of Agreeableness and Conscientiousness (Clark et al. 2012; Fridberg et al. 2011; Malouff et al. 2007; McCann 2010; Salujha et al. 2014; Vollrath and Torgersen 2008; Waga and Iwahashi 2007): Concerning tobacco consumption Waga and Iwahashi found significantly high scores of Openness in Japanese students who smoke (Waga and Iwahashi 2007). In their meta-analysis Malouff et al. revealed an association between alcohol consumption and high score of Neuroticism as well as low scores of Agreeableness and Conscientiousness (Malouff et al. 2007). So did Salujha et al. who additionally found high scores of Extraversion and Openness in alcohol dependent participants (Salujha et al. 2014) . In another study participants with high scores of Neuroticism and Extraversion did not only drink more alcohol than other participants but were also more prone to taking illicit drugs (Vollrath and Torgersen 2008). High scores of Openness and low scores of Agreeableness and Conscientiousness were revealed by Fridberg et al. in cannabis smokers (Fridberg et al. 2011).

While there exist many cross-sectional studies there is little literature concerning the predictive value of personality and substance use: Pluess and Bartley collected data suggesting high scores of Conscientiousness in adolescence to be a significant predictor for low tobacco smoking at the age of 50 (Pluess and Bartley 2015). Zvolensky et al. revealed high scores of Neuroticism and Openness as predictors for tobacco smoking within ten years in an US sample, whereas high scores of Conscientiousness seemed to be a protective factor for tobacco smoking or the development of occasional smoking to habitual smoking (Zvolensky et al. 2015).

Since most studies have a cross-sectional design, they focus on the association between the scores of the five dimensions of the NEO Five-Factor-Model of personality and substance use (Clark et al. 2012; Fridberg et al. 2011; Malouff et al. 2007; McCann 2010; Salujha et al. 2014; Vollrath and Torgersen 2008; Waga and Iwahashi 2007). Only few longitudinal studies exist with the focus on the predictive value of these dimensions for later substance use. The present study is the first one to examine this topic in a European 14 to 16-years-old sample, since at that age the onset of smoking, alcohol and cannabis consumption mostly occurs.

Methods

Participants

The test data were derived from the baseline assessment and first follow-up of the IMAGEN-Study, a European multicenter and multidisciplinary research project on adolescent mental health, under consideration of personality traits, brain activity and genetic predisposition (Schumann et al. 2010). The study started in December 2007 at eight study centers in England (London, Nottingham), Ireland (Dublin), France (Paris) and Germany (Berlin, Mannheim, Dresden, Hamburg). Follow-up examinations were performed at intervals of two and four years after the baseline assessment. The participants' recruitment took place in secondary schools and was based on two criteria: 1) Greatest possible diversity in terms of socio-economic status, cognitive and emotional development, 2) minimization of the ethnic heterogeneity by selecting a sample of young people with European ethnicity (Schumann et al. 2010).

For the present investigation, only the data of the baseline assessment (=T1) and first follow-up (=T2) were analyzed and only those participants were considered, who had completed the NEO Five-Factor-Inventory and ESPAD questionnaire: Those were 998 participants, 530 (53.1%) of them were males and 468 females. The average age at the baseline assessment was 14 years ± 3 months and at the first follow-up 16 years ± 3 months.

NEO Five-Factor-Inventory

The NEO Five-Factor-Inventory was adapted for the IMAGEN study and was part of a computerized test battery that the participants performed at each research institute using Psytools, Delosis UK. Participants rated how much each one of the 60 items applied to them on a Likert-scale ranging from "strongly agree" to "strongly disagree". Total scores for each dimension were derived from each participant's responses to the 12 items for each dimension ranging from 12 points to 60 points (McCrae and John 1992).

ESPAD

The by the European School Survey Project on Alcohol and other Drugs developed ESPAD questionnaire was also adapted for the IMAGEN study and part of the computerized test battery using Psytools, Delosis UK. The ESPAD questionnaire is widely used for international studies on prevalence of substance use and drug abuse among children and adolescents (Hibell et al. 2000; Hibell et al. 2004). In the present study three items were used, asking about the lifetime prevalence of tobacco, alcohol and cannabis consumption with the aim to distinguish adolescents with and without experiences with each substance.

Statistical analysis

IBM SPSS Statistics 21 for Windows was used for the analysis of the study data. The division of the mean scores of each dimension of the NEO Five-Factor-Model by their medians showed a normal distribution for each dimension. Therefore we used t-tests after alpha-adjustment via Bonferroni correction (p=0.0083) and ANOVA.

Ethics

The study protocol was approved by the local ethic boards of all study partners. Written informed consent was obtained from all legal guardians and assent was obtained from the adolescents.

Results

Participants came from three different nations: 432 from Germany (43%), 423 from Great Britain (42%) and 143 from Ireland (15%). On a percentage basis, at the age of 16 German participants had more experiences with tobacco, alcohol or cannabis. A significant difference could be found in experiences with tobacco (F=7.822, $p<0.001$) and alcohol (F=12.266, $p<0.001$) in German and British adolescents. Participants' experiences with substances at the age of 16 are shown in Figure 1.

Male and female participants were equally experienced.

As shown in Figure 2-4, analysis of NEO-FFI scores revealed that the mean scores of Neuroticism and Extraversion at T1 were higher for substance-experienced participants as compared to unexperienced participants at T2. However, a significant difference could only be found for Extraversion and tobacco smoking (t=3.357, $p<0.001$). Mean scores for Agreeableness at T1 in participants with substance experience at T2 were lower as compared in participants without experiences, which showed a significant difference in tobacco (t=-5.206, $p<0.001$) and cannabis experience (t=-2.806, p=0.005). Mean scores for Conscientiousness at T1 were significantly lower for all substance experienced participants as compared to unexperienced at T2 (t=-5.988, $p<0.001$; t=-3.804, $p<0.001$; t=-4.186, $p<0.001$). Mean scores for Openness at T1 did not differ significantly on participants with or without substance experiences at T2 and were lower in participants with tobacco experiences and higher in participants with alcohol and cannabis experiences, see Table 1.

Discussion

In our analysis on a large cohort of 998 adolescents, we found low scores of Agreeableness in 14-year-olds with later substance experiences, being significant with tobacco smoking and cannabis experiences as shown in Table 2. In terms of the Five Factor Model of personality, Agreeableness reflects a disposition to cooperation and compassionate as well as positive attitudes towards others (McCrae and John 1992). As these are attributes not commonly associated with substance users, a low score of Agreeableness in smokers and cannabis users in the present study was expected. The individual interest to consume a substance is placed first before interests of others. Furthermore, we found that a low score of Conscientiousness at the age of 14 is a significant predictive factor for experiences with all three substances at the age of 16. As Conscientiousness measures the level of self-discipline and reliability, a low score seems to imply that participants are more prone to trying out substances. This is supported by the findings in the present study as well in other studies (Pluess and Bartley 2015; Zvolensky et al. 2015).While for low scores of Conscientiousness Pluess and Bartley as well as Zvolensky et al. revealed the predictive value for later substance use, for low scores of Agreeableness Mallouff et al. as well as Salujha et al. and Fridberg et al. could only reveal an association, no study – as far as known - showed Agreeableness to be a predictive factor. Concomitant, several studies revealed an association between low scores of Conscientiousness and substance use (Fridberg et al. 2011; Malouff et al. 2007; Salujha et al. 2014), suggesting Conscientiousness being the most important predictive value of the dimensions of the NEO Five-Factor-Model of personality for later substance use and being an important factor for maintaining substance use.

We observed higher scores of Neuroticism in 14-year-olds who had substance experiences at the age of 16. These results were not significant however, as they were for Malouff et al. in tobacco smokers (Malouff et al. 2007) and for Salujha in alcohol dependent participants (Salujha et al. 2014) as well as Vollrath and Torgersen in alcohol consumers (Vollrath and Torgersen 2008). As these are cross-sectional studies, the results suggest that Neuroticism plays an important role in maintaining substance use but not necessarily in developing it. However, Zvolensky et al. found a significant coherence at high scores of Neuroticism and developing tobacco smoking examining an adult sample double the size of the present study (Zvolensky et al. 2015). High scores of Neuroticism indicate that participants tend to experience distress or sadness more often. Distress is one of the main reasons to initiate substance use as Hyman and Sinha found out for cannabis use (Hyman and Sinha 2009). Substance use might be used for emotional modulation. However, these findings cannot be supported by the present study with an adolescent cohort. As Salujha et al. and Vollrath and Torgersen, we found high scores of Extraversion in substance-experienced participants (Salujha et al. 2014; Vollrath and Torgersen 2008). However, our results were significant with tobacco smoking but not with cannabis or alcohol experiences. In alcohol abuse, level of sensitivity to alcohol rather than personality factors predict intake during adolescence (Hinckers et al. 2006). As Extraversion describes the disposition to be outgoing and sociable, participants with a high score on this dimension presumably can report of an easier availability of substances. These individuals can find stimulation in substance use in a social context such as smoking tobacco. While we could not reveal Openness to be a predictive factor for later substance experiences, several authors found an association between high scores of Openness and substance use (Fridberg et al. 2011; Salujha et al. 2014; Waga and Iwahashi 2007). Participants with a high score on Openness are curious for new experiences which they might find in the consumption of substances. Again, we refer to the cross-sectional designs of the other studies and smaller, adult samples as compared to our adolescent cohort.

Strengths and limitations

In the present study we used the NEO-FFI and ESPAD questionnaire which are retrospective instruments requiring participants' solid memory and truthful answers. However, being part of a computerized battery of questionnaires to be answered at home participants were able to take as much time as needed in a domestic environment.

A remarkable feature of the present work is the size and international nature of the study population with participants from different socio-economic backgrounds and developmental stages, presumably enabling the transfer of the results to a large part of European adolescents. However, only Caucasian adolescents were included so that a reliable transfer of the findings is limited to only this ethnic group. An extension of the study to other continents and ethnic groups may reveal further results and also allow regional comparisons. Considering future research projects, the longitudinal design of the IMAGEN study is another significant strength enabling tracking of cognitive and behavioral changes until adulthood and identifying predictive factors for later behaviours such as substance use.

Conclusion

The present study presents an investigation analyzing the predictive value of the NEO-FFI for the development of substance use on an adolescent European sample.

At this time, the NEO-FFI cannot be used as an ultimate predictive instrument for future substance experiences. However, a low score of Conscientiousness was the most important factor for a prediction of later experiences with substances in this study. Future studies should ascertain the causality of personality for substance use for the development of individual strategies for prevention and treatment of substance use and potential substance-related addiction.

Conflict of interests

The authors declare no conflict of interest.

References

Battistella G, Fornari E, Annoni JM, Chtioui H, Dao K, Fabritius M, Favrat B, Mall JF, Maeder P, Giroud C (2014) Long-term effects of cannabis on brain structure. Neuropsychopharmacology, 39(9), 2041-2048. doi: 10.1038/npp.2014.67

Centers for Disease Control & Prevention (2008) Smoking-attributable mortality, years of potential life lost, and productivity losses--United States, 2000-2004. MMWR Morb Mortal Wkly Rep, 57(45), 1226-1228

Clark A, Tran C, Weiss A, Caselli G, Nikcevic AV, Spada MM (2012) Personality and alcohol metacognitions as predictors of weekly levels of alcohol use in binge drinking university students. Addict Behav, 37(4), 537-540. doi: 10.1016/j.addbeh.2011.11.035

De Sousa KR, Tiwari AK, Giuffra DE, Mackenzie B, Zai CC, Kennedy JL (2013) Age at onset of schizophrenia: cannabis, COMT gene, and their interactions. Schizophr Res, 151(1-3), 289-290. doi: 10.1016/j.schres.2013.10.037

DeWit DJ, Adlaf EM, Offord DR, Ogborne AC (2000) Age at first alcohol use: a risk factor for the development of alcohol disorders. Am J Psychiatry, 157(5), 745-750

Dierker L, Selya A, Piasecki T, Rose J, Mermelstein R (2013) Alcohol problems as a signal for sensitivity to nicotine dependence and future smoking. Drug Alcohol Depend, 132(3), 688-693. doi: 10.1016/j.drugalcdep.2013.03.018

Fridberg DJ, Vollmer JM, O'Donnell BF, Skosnik PD (2011) Cannabis users differ from non-users on measures of personality and schizotypy. Psychiatry Res, 186(1), 46-52. doi: 10.1016/j.psychres.2010.07.035

Gallinat J, Meisenzahl E, Jacobsen LK, Kalus P, Bierbrauer J, Kienast T, Witthaus H, Leopold K, Seifert F, Schubert F, Staedtgen M (2006) Smoking and structural brain deficits: a volumetric MR investigation. Eur J Neurosci, 24(6), 1744-1750. doi: 10.1111/j.1460-9568.2006.05050.x

Grant JD, Scherrer JF, Lynskey MT, Lyons MJ, Eisen SA, Tsuang MT, True WR, Bucholz KK (2006) Adolescent alcohol use is a risk factor for adult alcohol and drug dependence: evidence from a twin design. Psychol Med, 36(1), 109-118. doi: 10.1017/S0033291705006045

Hibell B, Andersson B, Ahlström S, Balakireva O, Bjarnason T, Kokkevi A, Morgan M (2000) The 1999 ESPAD Report. Alcohol and Other Drug Use Among Students in 30 European Countries. The Swedish Council for Information on Alcohol and Other Drugs. Stockholm, Sweden

Hibell B, Andersson B, Bjarnason T, Ahlström S, Balakireva O, Kokkevi A, Morgan M (2004) The ESPAD Report 2003. Alcohol and Other Drug Use Among Students in 35 European Countries. The Swedish Council for Information on Alcohol and Other Drugs. Stockholm, Sweden

Hinckers AS, Laucht M, Schmidt MH, Mann KF, Schumann G, Schuckit MA, Heinz A (2006) Low level of response to alcohol as associated with serotonin transporter genotype and high alcohol intake in adolescents. Biol Psychiatry, 60(3), 282-287. doi: 10.1016/j.biopsych.2005.12.009

Hyman SM, Sinha R (2009) Stress-related factors in cannabis use and misuse: implications for prevention and treatment. J Subst Abuse Treat, 36(4), 400-413. doi: 10.1016/j.jsat.2008.08.005

Kandel D, Yamaguchi K (1993) From beer to crack: developmental patterns of drug involvement. Am J Public Health, 83(6), 851-855

Kuhn S, Romanowski A, Schilling C, Mobascher A, Warbrick T, Winterer G, Gallinat J (2012) Brain grey matter deficits in smokers: focus on the cerebellum. Brain Struct Funct, 217(2), 517-522. doi: 10.1007/s00429-011-0346-5

Malouff JM, Thorsteinsson EB, Rooke SE, Schutte NS (2007) Alcohol involvement and the Five-Factor model of personality: a meta-analysis. J Drug Educ, 37(3), 277-294

McCann SJ (2010) Subjective well-being, personality, demographic variables, and American state differences in smoking prevalence. Nicotine Tob Res, 12(9), 895-904. doi: 10.1093/ntr/ntq113

McCrae RR, John OP (1992) An introduction to the five-factor model and its applications. J Pers, 60(2), 175-215

Pluess M, Bartley M (2015) Childhood conscientiousness predicts the social gradient of smoking in adulthood: a life course analysis. J Epidemiol Community Health, 69(4), 330-338. doi: 10.1136/jech-2014-204263

Prescott CA, Kendler KS (2001) Early age at first alcoholic drink. Am J Psychiatry, 158(9), 1530

Salujha SK, Chaudhury S, Menon PK, Srivastava K, Gupta A (2014) Allelic variants of ADH, ALDH and the five factor model of personality in alcohol dependence syndrome. Ind Psychiatry J, 23(1), 44-51. doi: 10.4103/0972-6748.144956

Schumann G, Loth E, Banaschewski T, Barbot A, Barker G, Buchel C, Conrod PJ, Dalley JW, Flor H, Gallinat J, Garavan H, Heinz A, Itterman B, Lathrop M, Mallik C, Mann K, Martinot JL, Paus T, Poline JB, Robbins TW, Rietschel M, Reed L, Smolka M, Spanagel R, Speiser C, Stephens DN, Strohle A, Struve M and The IMAGEN consortium (2010) The IMAGEN study: reinforcement-related behaviour in normal brain function and psychopathology. Mol Psychiatry, 15(12), 1128-1139. doi: 10.1038/mp.2010.4

Vollrath ME, Torgersen S (2008) Personality types and risky health behaviors in Norwegian students. Scand J Psychol, 49(3), 287-292. doi: 10.1111/j.1467-9450.2008.00631.x

Waga C, Iwahashi K (2007) CYP2A6 gene polymorphism and personality traits for NEO-FFI on the smoking behavior of youths. Drug Chem Toxicol, 30(4), 343-349. doi: 10.1080/01480540701522338

Whelan R, Watts R, Orr CA, Althoff RR, Artiges E, Banaschewski T, Barker GJ, Bokde AL, Buchel C, Carvalho FM, Conrod PJ, Flor H, Fauth-Buhler M, Frouin V, Gallinat J, Gan G, Gowland P, Heinz A, Ittermann B, Lawrence C, Mann K, Martinot JL, Nees F, Ortiz N, Paillere-Martinot ML, Paus T, Pausova Z, Rietschel M, Robbins TW, Smolka MN, Strohle A, Schumann G, Garavan H and The IMAGEN consortium (2014) Neuropsychosocial profiles of current and future adolescent alcohol misusers. Nature, 512(7513), 185-189. doi: 10.1038/nature13402

Woicik PA, Stewart SH, Pihl RO, Conrod PJ (2009) The Substance Use Risk Profile Scale: a scale measuring traits linked to reinforcement-specific substance use profiles. Addict Behav, 34(12), 1042-1055. doi: 10.1016/j.addbeh.2009.07.001

Zvolensky MJ, Taha F, Bono A, Goodwin RD (2015) Big five personality factors and cigarette smoking: A 10-year study among US adults. J Psychiatr Res. doi: 10.1016/j.jpsychires.2015.02.008

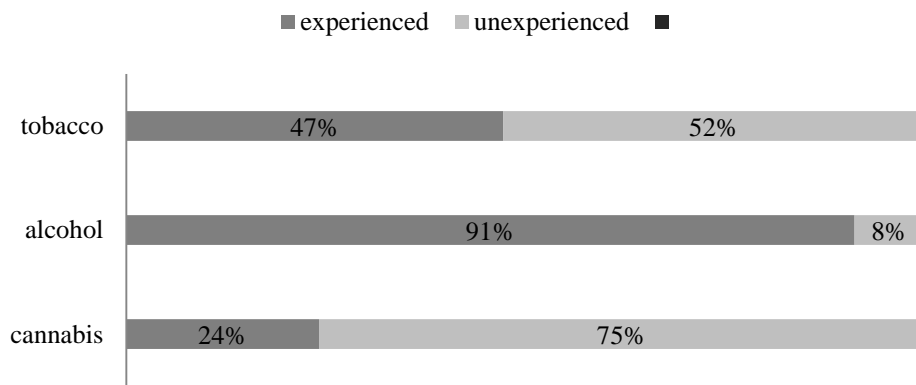**Figure 1** Experiences with substances at T2

Figure

Figure 2 NEO-FFI dimension scores for tobacco experienced (n=472) and unexperienced (n=526) participants
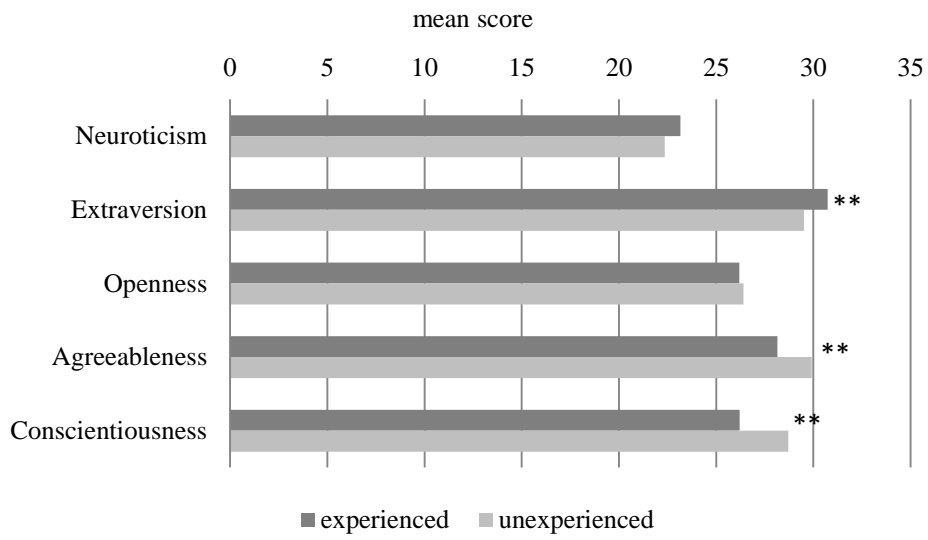** p<0.001, *t*-test

Figure 3 NEO-FFI dimension scores for alcohol experienced (n=911) and unexperienced (n=87) participants
** p<0.001, *t*-test

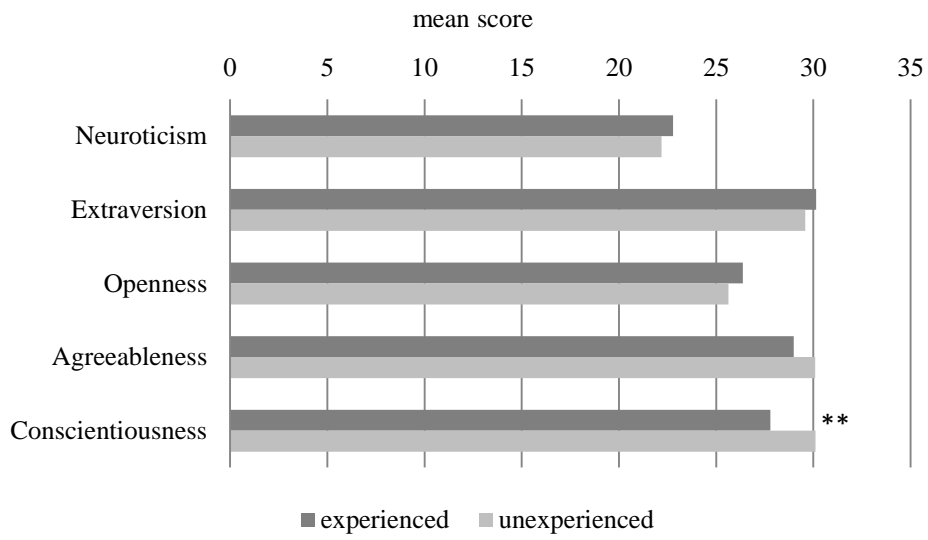**Figure 4** NEO-FFI dimension scores for cannabis experienced (n=241) and unexperienced (n=757) participants
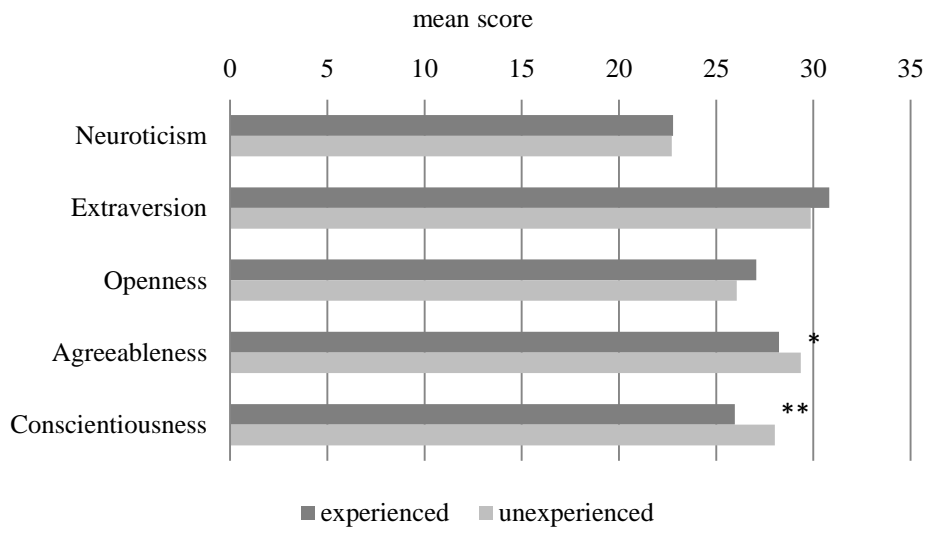*p<0.0083 ** p<0.001, *t*-test

Table 1 NEO-FFI dimension scores for substance experienced and unexperienced participants

	Factors	Mean (SD)		t-value	Cohen's d
		Experienced	**Unexperienced**		
Tobacco	Neuroticism	23.16 (7.59)	22.35 (7.13)	1.726	-0.11
	Extraversion	**30.73 (5.76)**	**29.51 (5.74)**	**3.357**	**-0.24**
	Openness	26.20 (6.05)	26.41 (5.92)	-0.548	0.035
	Agreeableness	**28.16 (5.44)**	**29.91 (5.17)**	**-5.206**	**0.33**
	Conscientiousness	**26.20 (6.29)**	**28.70 (6.85)**	**-5.988**	**0.379**
Alcohol	Neuroticism	22.78 (7.39)	22.20 (7.13)	0.712	-0.085
	Extraversion	30.14 (5.73)	29.58 (6.28)	0.864	-0.09
	Openness	26.37 (6.02)	25.63 (5.53)	1.101	-0.133
	Agreeableness	28.98 (5.42)	30.09 (4.75)	-1.843	0.231
	Conscientiousness	**27.27 (6.66)**	**30.12 (6.68)**	**-3.804**	**0.433**
Cannabis	Neuroticism	22.78 (7.50)	22.72 (7.32)	0.105	-0.008
	Extraversion	30.81 (6.01)	29.86 (5.69)	2.248	-0.165
	Openness	27.07 (6.15)	26.06 (5.91)	2.282	-0.169
	Agreeableness	**28.24 (5.14)**	**29.35 (5.42)**	**-2.806**	**0.207**
	Conscientiousness	**25.96 (6.51)**	**28.02 (6.39)**	**-4.186**	**0.321**

Table

Table 2 Score of dimensions in participants with substance experiences as compared to unexperienced participants.
* p>0.0086 **p<0.001, *t*-test

Factor	tobacco	alcohol	cannabis
Neuroticism	↑	↑	↑
Extraversion	↑**	↑	↑
Openness	↓	↑	↑
Agreeableness	↓**	↓	↓*
Conscientiousness	↓**	↓**	↓**