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Sensation seeking and cocaine dependence in adults with reported childhood ADHD

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Running title: ADHD, sensation seeking, and cocaine

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Samuele Cortese, M.D., Ph.D.: Samuele Cortese completed his M.D., his child neuropsychiatry residency and his Ph.D. in biomedical imaging at the University of Verona (Italy). He has worked as child psychiatrist/chief resident in Paris (France) and as Assistant Professor of Child Psychiatry at the François Rabelais University of Tours, France. He was Postdoctoral Research Fellow at the Institute for Pediatric Neuroscience of the New York University Child Study New Center, NYC, USA. He is currently Consultant Child Psychiatrist at the Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK. Dr. Cortese's main research interests focus on the neurobiology of ADHD. Dr. Cortese is author/co-author of 90 publications with impact factor (H factor: 26). Since 2009, he is a member of the European ADHD guidelines group.

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Conflicts of interest:

Nicolas Ballon: He has received financial support as chairman for medical meetings from AstraZeneca in 2010 & Lundbeck in 2013 and has been co-investigator in a study sponsored by DNAPharma in 2012-2013.

Paul Brunault: He has no potential or perceived conflicts of interest. He received no funding for this study.

Samuele Cortese: He received financial support to attend medical meetings from Eli Lilly & Company (2007-2009) and Shire Pharmaceuticals (2009-2010), and was co-investigator in studies sponsored by GlaxoSmithKline (2006), Eli Lilly & Company (2007-2008), and Genopharm (2008). He served as a consultant for Shire Pharmaceuticals (2009-2010).

Abstract

Objective: To compare measures of sensation seeking in a clinical group of cocaine-dependent (CD) patients with and without a history of probable childhood Attention-Deficit/Hyperactivity Disorder (ADHD) and in non-cocaine-dependent (NCD) healthy volunteers.

Method: Patients (n=75; 42 with and 33 without probable childhood ADHD) and comparisons (n=84) were assessed with the Diagnostic Interview for Genetic Studies, the Wender Utah Rating Scale for childhood ADHD, and the Zuckerman Seeking Sensation Scale.

Results: We found significantly higher prevalence rates of probable childhood ADHD in CD *vs.* NCD ($p < 0.001$). The mean total scores of sensation seeking were significantly higher in CD *vs.* NCD participants ($p < 0.001$) as well as in CD patients with *vs.* those without a probable history of childhood ADHD ($p < 0.001$).

Conclusions: Our study set the basis for longitudinal investigation assessing if the persistence of high level of sensation seeking in adults with childhood ADHD contribute to the transition to cocaine dependence.

Keywords: Substance use disorders; Cocaine; ADHD; sensation seeking.

Introduction

Substance use disorders (SUDs) are defined by a cluster of cognitive, behavioral, and physiological symptoms indicating persistent use of a substance despite significant substance-related problems (American Psychiatric Association, 2013). Among substances of abuse, cocaine is the second most frequently consumed illicit substance after cannabis. The most recent estimates by the United Nations Office on Drugs and Crime (UNODC) indicate that 17 million individuals used cocaine at least once in the past year, equivalent to 0.37% of the global population aged 15-64 yrs, with a higher annual prevalence use in wealthy countries: 1.5% in North America and 1.2% in Western and Central Europe (EU) (UNODC, World Drug Report 2013). In the EU, lifetime prevalence for cocaine use in adults ranges from 0.3% (Romania) to 9.6% (United Kingdom) (European Monitoring Centre for Drugs and Drug Addiction, a), while current prevalence for cocaine use ranges from 0.1% (Greece) to 2.7% (United Kingdom) (European Monitoring Centre for Drugs and Drug Addiction, b). In the French West Indies, where the present study was conducted, cocaine is mostly used in a more severe way, smoked as crack/cocaine, and its current prevalence has been estimated at 1% of the 15-44 year-old population (Merle, 2007).

Due to such high prevalence rates as well as related psychological and medical consequences, SUDs represent a major public health problem worldwide. A plethora of interplaying neurobiological and behavioral pathways have been posited to contribute to the heterogeneous clinical phenotype of SUDs (Meyers & Dick, 2010; Christensen, Low, & Anstey, 2006).

Attention-Deficit/Hyperactivity Disorder (ADHD), the most common neurodevelopmental disorder (Polanczyk et al., 2014), is another major public health issue. It is characterized by a persistent and impairing pattern of inattention and/or hyperactivity/impulsivity (American Psychiatric Association, 2013). Its worldwide-pooled prevalence is estimated at about 5% in school-age children (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007). Impairing symptoms of ADHD persist in adulthood in up to 65% of cases (Faraone, Biederman, & Mick, 2006), with a pooled prevalence of adulthood ADHD ~ 2.5% (Simon, Czobor, Balint, Meszaros, & Bitter, 2009).

Because of its core symptoms and comorbid disorders, ADHD imposes an enormous burden on society in terms of psychological dysfunction, adverse vocational outcomes, stress on families, and societal financial costs.

A large body of evidence shows that ADHD is often comorbid with other psychiatric conditions, such as oppositional defiant disorder/conduct disorder, specific learning disorders, mood and anxiety disorders, and sleep disturbances (Biederman & Faraone, 2005; Cortese et al., 2013).

Empirical evidence, summarized in three meta-analyses (Lee, Humphreys, Flory, Liu, & Glass, 2011; Charach, Yeung, Climans, & Lillie, 2011; van Emmerik-van et al., 2012), also supports a significant association of ADHD to SUDs, in particular nicotine, alcohol, marijuana, cocaine and other unspecified substances, although some recent data do not indicate a significance association between cocaine users and behavioral impulsivity or motor response inhibition (Vonmoos et al., 2013), which are typical features of ADHD. Individuals with cocaine dependence may also present with neuropsychological deficits that may be associated with ADHD, such as working memory impairment (Albein-Urios et al., 2012). As recently reviewed, several factors, including academic and vocational failure, social impairment, dysfunctional parenting, impulsive anger, as well as comorbid conduct and mood disorders, have been considered to mediate the link between ADHD and SUDs (Molina & Pelham, 2014).

The role of personality traits as mediating factor between ADHD and SUDs has been so far poorly investigated. Among these, “sensation seeking”, defined as readiness to approach novel stimuli and experiences (Blaskey, Harris, & Nigg, 2008), might be a possible candidate. A large body of evidence shows a significant association between sensation seeking and SUDs, including stimulant dependence (Ersche et al., 2010), in various populations, such as high school students (e.g., Pedersen, Clausen, & Lavik, 1989; Andrucci, Archer, Pancoast, & Gordon, 1989), college students (e.g., Galizio, Rosenthal, & Stein, 1983; Jaffe & Archer, 1987) and adults from clinical samples (e.g., Galizio & Stein, 1983; Spatz & Shontz, 1984). Significantly higher levels of sensation (or novelty) seeking compared to controls have been reported also in individuals with

ADHD (Cho et al., 2008; Purper-Ouakil et al., 2010; Yoo et al., 2006). Novelty seeking appears to be linked mostly to hyperactive/impulsive, rather than to inattentive, symptoms of ADHD (Purper-Ouakil et al., 2010).

Given the association of sensation seeking to both ADHD and SUDs, and the temporal pathway between ADHD and SUDs, sensation seeking might contribute to SUDs in adults with a history of childhood ADHD. The present study was conducted to assess the relationship among ADHD, cocaine dependence and sensation seeking as a basis for future longitudinal research testing the hypothesis that sensation seeking contributes to cocaine dependence in individuals with ADHD. Confirming this hypothesis would have important clinical and public health implications, since sensation seeking may be targeted in specific preventive-therapeutic strategies aimed at treating or decreasing SUDs in individuals with ADHD. This knowledge would be relevant for the ADHD specialist as well as for the addictologist in their clinical practice. We focused on patients with a specific SUD, i.e., cocaine use disorder, which has been quite overlooked in previous studies in ADHD. We assessed the prevalence of estimated childhood ADHD in cocaine-dependent (CD) patients and in a control group of non-cocaine-dependent (NCD) adults. The study objectives were to compare measures of sensation seeking in CD *vs.* NCD, as well as among subjects with CD plus a probable history of childhood ADHD (CD+), CD without a probable history of childhood ADHD (CD-), and NCD -. We expected: 1) Significantly higher prevalence rates of probable childhood ADHD in CD *vs.* NCD; 2) Significantly higher levels of sensation seeking in CD+ *vs.* CD-, as well as in CD (+ or – or both) *vs.* NCD.

Methods

Participants

Participants were from the Addiction Treatment Unit (ATU) of Fort-de-France Hospital, in the French West Indies. Inclusion criteria were: age < 18 years and a diagnosis of cocaine dependence according to the to the DSM-IV-TR criteria (American Psychiatric Association, 2000).

Current or past treatment with any ADHD medication, that may have impacted the results, was an exclusion criterion. Seventy-five male outpatients consecutively referred for crack/cocaine use (as mentioned in the introduction, in the French West Indies cocaine is usually smoked as crack/cocaine) met the study criteria in the 12-month study period. All participants had been abstinent, as per self-report, for at least two weeks before entering the study (no urine analysis was carried out to verify participants' self-report). Eighty-four males (>18 years) were recruited as comparisons (NCD) from the blood transfusion center of the same hospital. Inclusion criterion for comparisons was the absence of personal and first-degree relatives' psychiatric disorders, including any SUD. The local ethics committee approved this study and all subjects gave their written informed consent after the procedure had been fully explained.

Assessment

All participants (including NCD) were assessed with the Diagnostic Interview of Genetic Studies (DIGS) (Nurnberger, Jr. et al., 1994). The French version of this instrument (Leboyer et al., 1991) revealed high kappa coefficients for inter-rater reliability and slightly lower kappas for test-retest reliability (Berney, Preisig, Matthey, Ferrero, & Fenton, 2002; Preisig, Fenton, Matthey, Berney, & Ferrero, 1999).

Participants were also asked to complete the Zuckerman's sensation-seeking scale and the Wender Utah Rating Scale (WURS). The Zuckerman's sensation-seeking scale, Form V (Zuckerman & Link, 1968) is a 40-item scale that measures an individual's preference to seek novel and complex experiences. Items present two opposing statements and respondents are asked to choose the one that most closely matches their "likes or feelings." The scale has four subscales: Disinhibition, Danger Seeking, Exploration Seeking, Boredom Susceptibility, and Disinhibited Behavior, and a total score. Retest reliability statistics obtained over a period of four to six weeks showed strong test-retest reliability ($r = 0.87$) (Zuckerman & Link, 1968). A French version of the Zuckerman's sensation-seeking scale, Form V is available; component analyses on this version

support the four distinct dimensions of sensation seeking (Carton, Jouvent, & Widlocher, 1992). The WURS (Ward, Wender, & Reimherr, 1993) was developed to evaluate ADHD symptoms in childhood. It is a self-report measure with a Likert-type scale including choices from 0 to 4 (0 = none, 4 = severe). It demonstrated satisfactory internal consistency and temporal stability (Stein et al., 1995). The French version of the WURS (25 items, WURS-25) showed high reliability and very good stability (Caci, Bouchez, & Bayle, 2010). As recommended by the authors of the WURS, the cut-off suggestive of a probable childhood history of ADHD is 46 (Ward et al., 1993).

Statistical analyses

Descriptive statistics were presented as means or percentage and standard deviations. CD and NCD participants were compared on age, age at onset of substance abuse, and Zuckerman's sensation-seeking scores using one-way ANOVA. In addition, CD participants with probable ADHD, those without probable childhood ADHD and NCD participants were compared on age and Zuckerman's sensation-seeking scores using one-way ANOVAs. Post-hoc analyses used the Tukey's test to examine pairwise differences among the three study groups. All tests were two-tailed with an alpha set at 0.01 for significance. Analyses were performed using the SAS version 9.1 software for Windows (SAS Institute, Inc., Cary, NC, USA)

Results

We included 75 CD and 84 NCD participants. CD were significantly younger than NCD ($F(1,157)= 7.29, p=0.008$). CD+ and CD- did not significantly differ with regard to their mean ages, mean ages at onset of cocaine smoking, cannabis or alcohol abuse (Table 1 and Table 2). CD- were younger than NCD, with a trend for statistical significance ($p= 0.029$) in relation to our threshold ($p=0.01$) (Table 1). Further legal and illicit drug use patterns/dependencies are reported in Table 3.

Using a score higher than 46 on the WURS-25 scale as an indicator of childhood ADHD, 42 (56%) out of 75 CD had an estimated history of childhood ADHD. Only 4 (4.7%) out of 84 NCD

presented with estimated childhood ADHD. Mean WURS scores in CD+ and CD- were, respectively, 59.8 (sd: 24) and 25.4 (sd: 12.9).

The Zuckerman's sensation-seeking total score ($F(1,158) = 95.6, p < 0.001$), the disinhibition ($F(1,158) = 221.94, p < 0.001$) and the boredom susceptibility ($F(1,158) = 153.9, p < 0.001$) sub-scores were significantly higher in CD, irrespective of childhood ADHD status, compared to NCD. The total Zuckerman's sensation-seeking score and the boredom susceptibility sub-scores were significantly higher in CD+ vs. CD- ($p < 0.001$ in both comparisons). A trend to significance was found for higher disinhibition and danger-seeking subscales in CD+ vs. CD- (respectively $p = 0.062$ and $p = 0.027$) (Table 1). Compared to NCD, both CD+ and CD- had significantly higher total Zuckerman's sensation-seeking scores, boredom susceptibility and disinhibition sub-scores ($p < 0.001$ for all). CD- had also higher danger seeking sub-scores, with a trend for statistical significance ($p = 0.066$) (Table 1).

Discussion

To our knowledge, this is the first study that assessed sensation seeking levels in a sample of cocaine dependent (CD) adults with a probable history of childhood ADHD, in a group of CD without probable childhood ADHD, and in a group of non-cocaine-dependent (NCD) adults.

In relation to the first study aim, as hypothesized, the prevalence of estimated ADHD was significantly higher in CD vs. NCD participants. The prevalence of childhood ADHD (56%) that we found in CD participants is overall consistent with the upper-level estimate of ADHD prevalence in treatment-seeking adults with SUD in a recent meta-analysis (23.3%, CI: 17.7%-30.1%) (van Emmerik-van et al., 2012). Indeed, considering that up to 65% of individuals with a childhood diagnosis of ADHD continue to present impairing symptoms of ADHD in adulthood (Faraone et al., 2006), the upper limit reported by van Emmerik-van et al. would be in line with our finding. Of note, we included only males with cocaine dependency according to DSM-IV criteria; patients with a less severe substance abuse disorders, such as abusers, were not included in our sample. In

addition, our subjects presented with a severe form of cocaine dependence (smoked cocaine as crack/cocaine). All these factors could contribute to explain the high rate of childhood ADHD found in the present study (56%) compared to previous studies included in the van Emmerik-van et al. meta-analysis, possibly recruiting less severe SUD patients.

We also confirmed the second hypothesis of our study, since the levels of sensation seeking were significantly higher in CD *vs.* NCD participants and, in those with CD, they were significantly higher in participants with a probable childhood history of ADHD. However, we did not find this pathway for all the sub-scores of the Zuckerman's sensation-seeking scale. In previous studies conducted in patients with other SUDs, the total score is often taken as the main outcome variable, although the four subscales of the Sensation Seeking Scale do not behave identically (Miller & Lynam, 2013). As an example, patients with an alcohol use disorder reported significant differences among the subscales in their overall relations to alcohol use, with disinhibition showing the largest effects and danger and exploration seeking showing the smallest effects (Hittner & Swickert, 2006). In our study, while the sensation-seeking total score and the boredom susceptibility sub-scores were significantly higher in CD with *vs.* those without estimated childhood ADHD, this was not the case for the other sub-scores. However, the trend for statistical significance that we found in relation to the disinhibition and the danger seeking subscales suggests that a larger sample might show additional significant differences.

Although the cross-sectional nature of our study does not allow to test causality mechanisms, our results provide initial support to the hypothesis that high levels of sensation seeking may contribute to SUDs (in particular, cocaine dependence) in individuals with childhood ADHD, setting the basis for future longitudinal studies aimed to test this hypothesis. This is consistent with a previous study conducted in 43 undergraduate students with ADHD pharmacologically treated with methylphenidate or mixed amphetamine salts (Jardin, Looby, & Earleywine, 2011). The study showed that, compared to non-misusers, misusers of methylphenidate or mixed amphetamine salts were significantly more likely to report using a greater number of illicit

substances, including nicotine, marijuana, cocaine, hallucinogens, and opiates, over the past year as well as to have significantly higher sensation seeking scores. Our results are also partially in line with the findings of another larger study in 660 undergraduate students showing that high sensation seeking scores moderated the association between ADHD symptoms and misuse of over-the-counter stimulants, although the misuse of illicit stimulant was moderated by conduct problems rather than by high levels of sensation seeking (Van, Markle, & Flory, 2012).

Among the potential personality traits associated with substance abuse, high sensation seeking is a core dimension since it has been demonstrated to be a more powerful predictor of initial drug use and abuse across drug categories than any other measures of personality and psychopathology (Stelmack, 2004). To explain the association between high sensation seeking and SUD, different hypotheses have been proposed. On a theoretical ground, high sensation seeking could contribute to increased vulnerability to drug addiction, but it could also reflect psychobiological adaptations to chronic drug exposure (Belin & Deroche-Gamonet, 2012). Available data from studies conducted in substance abusers strongly support the hypothesis that high sensation seeking contributes to the development of abuse (Stelmack, 2004). More specifically, high sensation seeking may directly heighten risk for substance abuse due to relatively fixed, presumably brain-based, sensitivities to the positive (e.g. pleasurable arousal, social facilitation or taking illegal risks) and negative (e.g. stress reduction or negative affect regulation) reinforcement properties of psychoactive substances (Stelmack, 2004). Another hypothesis is that high levels of sensation seeking may also indirectly contribute to substance use and abuse via pro-drug interactions with deviant peers (Yanovitzky, 2005). Although studies are less numerous in cocaine abusers, they demonstrate the importance of this personality trait showing that patients with high levels of sensation seeking had an earlier age of onset for substance use and abuse, exhibited more severe symptoms of substance abuse, exhibited more severe psychosocial impairment, and were more likely to be polysubstance abusers (Ball, Carroll, & Rounsaville, 1994). In animal models, sensation seeking predicted more specifically vulnerability to use cocaine but not

vulnerability to shift from controlled to compulsive cocaine use (Belin & Deroche Gamonet 2012). Since adolescents with ADHD have been shown to be more vulnerable to the negative social influences of deviant groups compared to non-ADHD controls (Marshal, G, & Pelham Jr., 2003), one might assume that high sensation and ADHD might have a cumulative effect on subsequent risk to develop cocaine abuse. Further studies in human are needed to test these hypotheses.

Our results should be considered in the light of some study limitations. First, as already mentioned, the cross-sectional nature of the study does not allow to test causal pathways; however, it provides first evidence that supports further longitudinal investigation. Second, we could not establish a formal diagnosis of childhood ADHD. However, a score of 46 or higher in the WURS, that we used in the present study as indicative of childhood ADHD, has been showed to correctly identify 86% of patients with formally diagnosed ADHD (Ward et al., 1993). In addition, Dakwar et al. (2012), after comparing the sensitivity of the WURS, the Conners Adult ADHD Rating Scale and the Adult ADHD Self-Report Scale- Version 1.1 (ASRS-V1.1), concluded that the WURS had the highest sensitivity in regard to the broadest range of ADHD cases. Third, we were not able to assess childhood conduct disorder and control for this factor in our analyses. However, although it is common to take conduct disorder into account in studies addressing the link between ADHD and SUDs, as correctly pointed out by Molina and Pelham (2014), “such an approach may remove key components of ADHD, such as impulsivity, that are associated with ADHD and CD and that are important for the prediction of atypical levels of substance use”.

Despite these limitations, our study suggest that high levels of sensation seeking might contribute to SUD (in particular, cocaine dependence) in individuals with ADHD. If further longitudinal evidence confirms our finding, childhood ADHD and sensation seeking measures should be taken into account to better define and characterize the phenotype of cocaine dependent subjects in future research in the field. Assessing and appropriately managing sensation seeking dimensions may contribute to improve the clinical practice with SUD patients with childhood history of ADHD. In particular, cocaine dependents with and without history of ADHD may require

different management strategies, paving the way for the development of patient-related individualized therapies according to specific personality traits profile.

References

- Albein-Urios, N., Martinez-Gonzalez, J.M., Lozano, O., Clark, L., Verdejo-Garcia, A, (2012). Comparison of impulsivity and working memory in cocaine addiction and pathological gambling: Implications for cocaine-induced neurotoxicity. *Drug Alcohol Depend*, 126,1-6.
- American Psychiatric Association (2000). *Diagnostic and Statistical Manual of Mental Disorders, 4th ed. Text revision*. Washington DC.
- American Psychiatric Association (2013). *Diagnostic and Statistical Manual of mental Disorders, Fifth Edition, DSM-5*. (American Psychiatric Publishing ed.) Washington, DC.
- Andrucci, G. L., Archer, R. P., Pancoast, D. L., & Gordon, R. A. (1989). The relationship of MMPI and Sensation Seeking Scales to adolescent drug use. *J Pers Assess*, 53, 253-266.
- Ball, S. A., Carroll, K. M., & Rounsaville, B. J. (1994). Sensation seeking, substance abuse, and psychopathology in treatment-seeking and community cocaine abusers. *J Consult Clin Psychol*, 62, 1053,1057.
- Belin, D., & Deroche-Gamonet, V. (2012). Responses to Novelty and Vulnerability to Cocaine Addiction: Contribution of a Multi-Symptomatic Animal Model. *Cold Spring Harb Perspect Med*, 2. doi:10.1101/cshperspect.a011940.
- Berney, A., Preisig, M., Matthey, M. L., Ferrero, F., & Fenton, B. T. (2002). Diagnostic interview for genetic studies (DIGS): inter-rater and test-retest reliability of alcohol and drug diagnoses. *Drug Alcohol Depend.*, 65, 149-158.
- Biederman, J. & Faraone, S. V. (2005). Attention-deficit hyperactivity disorder. *Lancet*, 366, 237-248.
- Blaskey, L. G., Harris, L. J., & Nigg, J. T. (2008). Are sensation seeking and emotion processing related to or distinct from cognitive control in children with ADHD? *Child Neuropsychol*, 14, 353-371.

- Caci, H. M., Bouchez, J., & Bayle, F. J. (2010). An aid for diagnosing attention-deficit/hyperactivity disorder at adulthood: psychometric properties of the French versions of two Wender Utah Rating Scales (WURS-25 and WURS-K). *Compr Psychiatry, 51*, 325-331.
- Carton, S., Jouvent, R., & Widlocher, D. (1992). Cross-cultural validity of the Sensation Seeking Scale: Development of a French abbreviated form. *European Psychiatry, 7*, 225-234.
- Charach, A., Yeung, E., Climans, T., & Lillie, E. (2011). Childhood attention-deficit/hyperactivity disorder and future substance use disorders: comparative meta-analyses. *J Am Acad Child Adolesc Psychiatry, 50*, 9-21.
- Cho, S. C., Hwang, J. W., Lyoo, I. K., Yoo, H. J., Kin, B. N., & Kim, J. W. (2008). Patterns of temperament and character in a clinical sample of Korean children with attention-deficit hyperactivity disorder. *Psychiatry Clin Neurosci, 62*, 160-166.
- Christensen, H., Low, L. F., & Anstey, K. J. (2006). Prevalence, risk factors and treatment for substance abuse in older adults. *Curr Opin Psychiatry, 19*, 587-592.
- Cortese, S., Brown, T. E., Corkum, P., Gruber, R., O'Brien, L. M., Stein, M. et al. (2013). Assessment and management of sleep problems in youths with attention-deficit/hyperactivity disorder. *J Am Acad Child Adolesc Psychiatry, 52*, 784-796.
- Dakwar, E., Mahony, A., Pavlicova, M., Glass, A., Brooks, D., Mariani, J.J., Grabowski, J., Levin F.R. (2012). The utility of attention-deficit/hyperactivity disorder screening instruments in individuals seeking treatment for substance use disorders. *J Clin Psychiatry, 2012*, e1372-8.
- Ersche, K.D., Turton, A.J., Pradhan, S., Bulmore, E.T., Robbins, T.W. (2010). Drug addiction endophenotypes: impulsive versus sensation-seeking personality traits. *Biol Psychiatry, 68*, 770-3
- European Monitoring Centre for Drugs and Drug Addiction (a).
<http://www.emcdda.europa.eu/stats13#display:/stats13/gpstab1b>. Accessed on June 12, 2014
- European Monitoring Centre for Drugs and Drug Addiction (b).
<http://www.emcdda.europa.eu/stats13#display:/stats13/gpstab2a>. Accessed on June 12, 2014

- Faraone, S. V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: a meta-analysis of follow-up studies. *Psychol Med*, *36*, 159-165.
- Galizio, M., Rosenthal, D., & Stein, F. A. (1983). Sensation seeking, reinforcement, and student drug use. *Addict Behav*, *8*, 243-252.
- Galizio, M. & Stein, F. S. (1983). Sensation seeking and drug choice. *Int J Addict*, *18*, 1039-1048.
- Hittner, J. B., & Swickert, R. (2006). Sensation seeking and alcohol use: A meta-analytic review. *Addict Behav*, *31*, 1383,1401.
- Jaffe, L. T. & Archer, R. P. (1987). The prediction of drug use among college students from MMPI, MCMI, and sensation seeking scales. *J Pers Assess*, *51*, 243-253.
- Jardin, B., Looby, A., & Earleywine, M. (2011). Characteristics of college students with attention-deficit hyperactivity disorder symptoms who misuse their medications. *J Am Coll Health*, *59*, 373-377.
- Leboyer, M., Maier, W., Teherani, M., Lichtermann, D., D'Amato, T., Franke, P. et al. (1991). The reliability of the SADS-LA in a family study setting. *Eur Arch Psychiatry Clin Neurosci*, *241*, 165-169.
- Lee, S. S., Humphreys, K. L., Flory, K., Liu, R., & Glass, K. (2011). Prospective association of childhood attention-deficit/hyperactivity disorder (ADHD) and substance use and abuse/dependence: A meta-analytic review. *Clin Psychol Rev*, *31*, 328-341.
- Marshal, M. P., Molina, B. S., & Pelham Jr., W. E. (2003). Childhood ADHD and Adolescent Substance Use: An Examination of Deviant Peer Group Affiliation as a Risk Factor. *Psychol Addict Behav*, *17*, 293,302.
- Merle, S. Estimation locale de l'usage problématique de drogues : l'enquête NEMO. OSM-Flash 2007;40.
- Meyers, J. L. & Dick, D. M. (2010). Genetic and environmental risk factors for adolescent-onset substance use disorders. *Child Adolesc Psychiatr Clin N Am*, *19*, 465-477.
- Miller, J. D., & Lynam, D. R. (2013). Personality and Addiction: A Critical Review of Assessment

Approaches. In J. McKillop & H de Wit (Eds.), *The Wiley-Blackwell Handbook of Addiction Psychopharmacology*, (pp.111-133). New Delhi, India: John Wiley & Sons.

Molina, B. S. & Pelham, W. E. (2014). Attention-Deficit/Hyperactivity Disorder and Risk of Substance Use Disorder: Developmental Considerations, Potential Pathways, and Opportunities for Research. *Annu Rev Clin Psychol*.

Nurnberger, J. I., Jr., Blehar, M. C., Kaufmann, C. A., York-Cooler, C., Simpson, S. G., Harkavy-Friedman, J. et al. (1994). Diagnostic interview for genetic studies. Rationale, unique features, and training. NIMH Genetics Initiative. *Arch Gen Psychiatry*, 51, 849-859.

Pedersen, W., Clausen, S. E., & Lavik, N. J. (1989). Patterns of drug use and sensation-seeking among adolescents in Norway. *Acta Psychiatr Scand*, 79, 386-390.

Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., & Rohde, L. A. (2007). The worldwide prevalence of ADHD: a systematic review and metaregression analysis. *Am J Psychiatry*, 164, 942-948.

Polanczyk, G.V., Willcutt EG, Salum GA, Kieling C, Rohde LA (2014). ADHD prevalence estimates across three decades: an updated systematic review and meta-regression analysis. *Int J Epidem* 2014;434-42.

Preisig, M., Fenton, B. T., Matthey, M. L., Berney, A., & Ferrero, F. (1999). Diagnostic interview for genetic studies (DIGS): inter-rater and test-retest reliability of the French version. *Eur Arch Psychiatry Clin Neurosci*, 249, 174-179.

Purper-Ouakil, D., Cortese, S., Wohl, M., Aubron, V., Orejarena, S., Michel, G. et al. (2010). Temperament and character dimensions associated with clinical characteristics and treatment outcome in attention-deficit/hyperactivity disorder boys. *Compr Psychiatry*, 51, 286-292.

Simon, V., Czobor, P., Balint, S., Meszaros, A., & Bitter, I. (2009). Prevalence and correlates of adult attention-deficit hyperactivity disorder: meta-analysis. *Br J Psychiatry*, 194, 204-211.

Spotz, J. V., & Shontz, F. C. (1984). Correlates of sensation seeking by heavy, chronic drug users. *Percept Mot Skills*, 58, 427-435.

- Stein, M. A., Sandoval, R., Szumowski, E., Roizen, N., Reinecke, M. A., Blondis, T. A. et al. (1995). Psychometric characteristics of the Wender Utah Rating Scale (WURS): reliability and factor structure for men and women. *Psychopharmacol Bull*, 31, 425-433.
- Stelmack, R.N. (2004). *On the psychobiology of personality. Essays in honor of Marvin Zuckerman*. Oxford: Elsevier.
- United nations Office on Drugs and Crime (UNDOC).
http://www.unodc.org/unodc/secured/wdr/wdr2013/World_Drug_Report_2013.pdf. Accessed on June 12, 2014.
- van Emmerik-van, O. K., van de Glind, G., van den Brink, W., Smit, F., Crunelle, C. L., Swets, M. et al. (2012). Prevalence of attention-deficit hyperactivity disorder in substance use disorder patients: a meta-analysis and meta-regression analysis. *Drug Alcohol Depend.*, 122, 11-19.
- Van, E. K., Markle, R. S., & Flory, K. (2012). Do conduct problems and sensation seeking moderate the association between ADHD and three types of stimulant use in a college population? *Psychol Addict Behav*, 26, 939-947.
- Vonmoos, M., Hulka, L.M., Preller, K.H., Jenni, D., Schulz, C., Baumgarther, M.R., Quednow, B.B. Differences in self-reported and behavioral measures of impulsivity in recreational and dependent cocaine users. *Drug Alcohol Depend*, 133, 61-70.
- Ward, M. F., Wender, P. H., & Reimherr, F. W. (1993). The Wender Utah Rating Scale: an aid in the retrospective diagnosis of childhood attention deficit hyperactivity disorder. *Am J Psychiatry*, 150, 885-890.
- Yanovitzky, I. (2005). Sensation seeking and adolescent drug use: The mediating role of association with deviant peers and pro-drug discussions. *Health Commun*, 17, 67–89.
- Yoo, H. J., Kim, M., Ha, J. H., Chung, A., Sim, M. E., Kim, S. J. et al. (2006). Biogenetic temperament and character and attention deficit hyperactivity disorder in Korean children. *Psychopathology*, 39, 25-31.

Zuckerman, M. & Link, K. (1968). Construct validity for the sensation-seeking scale. *J Consult Clin Psychol*, 32, 420-426.

Table 1. Age, and scores [mean (standard deviation)] on the Zuckerman's sensation-seeking scale in smoked-cocaine dependents with and without childhood ADHD and in comparisons.

	CD <i>n=75</i>	CD + <i>n=42</i>	CD - <i>n=33</i>	NCD <i>n=84</i>	ANOVA (CD vs. NCD)		ANOVA (CD+ vs. CD- vs. NCD)		Post-hoc tests (Tukey)		
					F	p	F	p	p CD+ vs. CD -	p CD+ vs. NCD	p CD - vs. NCD
Age	36 (6.6)	36.7 (6.5)	35.1 (6.8)	39.7 (10.2)	7.29	0.008	3.93	0.021	0.720	0.157	0.029
Zuckerman scale total score	24.97 (4.8)	27.4 (4.1)	21.9 (4.0)	16.7 (5.7)	95.60	< 0.001	65.74	< 0.001	< 0.001	< 0.001	< 0.001
Disinhibition	7.25 (1.9)	7.7 (1.6)	6.7 (2.2)	2.8 (1.9)	221.94	< 0.001	116.49	< 0.001	0.062	< 0.001	< 0.001
Danger seeking	6.4 (3.1)	7.2 (2.5)	5.5 (3.6)	6.8 (2.5)	0.56	0.453	3.69	0.027	0.027	0.720	0.066
Exploration seeking	4.6 (2.1)	5.0 (2.2)	4.1 (1.9)	4.8 (2.1)	0.43	0.512	1.81	0.167	0.178	0.910	0.230
Boredom susceptibility	6.6 (2.6)	7.5 (1.7)	5.5 (3.1)	2.3 (1.7)	153.9	< 0.001	92.8	< 0.001	< 0.001	< 0.001	< 0.001

CD: Cocaine dependents; NCD: Non cocaine dependents; CD +: Cocaine dependents with Attention-Deficit/Hyperactivity Disorder; CD - : Cocaine dependents without Attention-Deficit/Hyperactivity Disorder

Table 2. Age of onset of cocaine, cannabis, and alcohol misuse in cocaine dependents with ADHD (CD+) and cocaine dependents without ADHD (CD-).

	CD +	CD -	ANOVA	
			F	p
Age onset cocaine misuse	26.7 (3.9)	26.6 (4.1)	0.20	0.888
Age onset cannabis misuse	20.7 (4.2)	21.5 (3.8)	0.63	0.427
Age onset alcohol misuse	24.0 (4.3)	22.3 (4.5)	2.42	0.124

Table 3. Legal and illicit drug use patterns/dependencies among cocaine dependents.

	Alcohol			Cannabis		
	<i>Abuse</i>	<i>Dependence</i>	<i>No abuse/dependence</i>	<i>Abuse</i>	<i>Dependence</i>	<i>No abuse/dependence</i>
CD +	33 (78.6%)	4 (9.5%)	5 (11.9%)	41 (97.6%)	1 (2.4%)	0 (0%)
CD -	25 (75.8%)	2 (6%)	6 (18.2%)	32 (97%)	0 (0%)	1 (3%)

CD +: Cocaine dependents with Attention-Deficit/Hyperactivity Disorder; CD - : Cocaine dependents without Attention-Deficit/Hyperactivity Disorder