

Brief Report

Impulsivity and Symptoms of Nicotine Dependence in a Young Adult Population

Henry W. Chase, Ph.D., & Lee Hogarth, Ph.D.

School of Psychology, University of Nottingham, University Park, Nottingham, UK

Corresponding Author: Henry W. Chase, Department of Psychiatry, Western Psychiatric Institute and Clinic, University of Pittsburgh School of Medicine, Pittsburgh, PA 15213, USA. Telephone: 412-383-8207; Fax: 412-383-8336; E-mail: chaseh@upmc.edu

Henry W. Chase is now at Department of Psychiatry, Western Psychiatric Institute and Clinic, University of Pittsburgh School of Medicine.

Received March 10, 2011; accepted April 27, 2011

Abstract

Introduction: Impulsivity is widely regarded as a risk factor for drug dependence. However, its relationship with the symptomatology of nicotine dependence is poorly understood.

Methods: To examine the nature of these relationships, we recruited 404 daily and occasional smokers from a predominantly student population and assessed the association between impulsivity, as measured by the Barratt Impulsiveness Scale (BIS-11) and several self-reported measures of smoking rate and nicotine dependence, including the Diagnostic and Statistical Manual's (DSM-IV) criteria.

Results: Overall, impulsivity was high throughout the entire sample but only modestly associated with nicotine dependence. Within the diagnostic criteria of nicotine dependence, two symptoms, which reflect automatized or habitual smoking, were most strongly associated with impulsivity.

Conclusion: These data support recent human and animal work, which suggests that impulsivity is linked to the formation of habitual drug use, and are discussed within the framework of a dual-system account of drug seeking.

Introduction

Impulsivity is a multidimensional construct generally regarded as a predisposition to make risky decisions without adequate forethought and is well established as a vulnerability factor for drug dependence in humans (Verdejo-Garcia, Lawrence, & Clark, 2008) and animals (Belin, Mar, Dalley, Robbins, & Everitt, 2008; Dalley et al., 2007; Diergearde et al., 2008). However, it remains unclear how the trait might have this influence. One view is that impulsivity increases the rewarding effects of some drugs of abuse and consequently intentional or goal-directed drug seeking (Hogarth & Chase, *in press*), thereby enhancing acquisition of self-administration behavior (Dalley et al., 2007; Diergearde et al., 2008). Consistent with this view, impulsivity has been

shown to influence the subjective rewarding effects of nicotine (Perkins et al., 2008) and explicit expectancies about nicotine reward (Doran, McChargue, & Cohen, 2007) in humans.

Another view is that impulsivity might accelerate transition to automatic or habitual drug self-administration. Key evidence for this view arises from a rodent paradigm designed to model aspects of "compulsive" drug seeking, the clinical observation of human perseverative drug seeking despite deleterious consequences observed in substance-dependent humans (Vanderschuren & Everitt, 2004). In this model, rats respond for cocaine despite receiving an aversive shock. Belin et al. (2008) demonstrated that high impulsive rats made a more rapid transition to shock-resistant drug seeking. Furthermore, we have found evidence for impaired goal-directed (and hence more automatic) choice in an outcome devaluation procedure (Hogarth, Chase, & Baess, 2010) in smokers with high levels of motor impulsivity, assessed by the Barrett Impulsiveness Scale (BIS-11: Patton, Stanford, & Barratt, 1995). High levels of impulsivity were also associated with a decoupling of smoking consumption from subjective craving, again suggestive of automatized behavior (Hogarth, 2011).

Supporting both positions, Diergearde et al. (2008) recently observed that two types of impulsive behavior in rats had dissociable effects on the uptake and perseveration of nicotine self-administration in extinction. Specifically, premature responding in the five-choice task predicted higher rates of nicotine self-administration, suggesting hypersensitivity to drug reinforcement. On the other hand, rats showing greater delay discounting showed delayed extinction of nicotine self-administration, perhaps suggestive of inflexible automatized behavior. Likewise, in humans, impulsivity both increases smoking uptake and interferes with quitting (Audrain-McGovern et al., 2009; Flory & Manuck, 2009; Powell, Dawkins, West, Powell, & Pickering, 2010).

We have obtained a substantial dataset as a result of several studies of daily smokers and "light or intermittent" smokers (Coggins, Murrelle, Carchman, & Heidbreder, 2009; Shiffman, 1989), recruited predominantly from a student population, in which we had recorded a variety of measures of nicotine use. We

doi: 10.1093/ntr/ntr114

Advance Access published on August 17, 2011

© The Author 2011. Published by Oxford University Press on behalf of Society for Research on Nicotine and Tobacco.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

considered this group as providing a comprehensive cross-section of the full range of smoking behavior in a young adult population, many of whom were at an early stage of a nicotine addiction. In light of animal studies of the effect of impulsivity on drug seeking (Belin et al., 2008; Dalley et al., 2007; Diergaarde et al., 2008) and our previous observations (Hogarth, 2011; Hogarth et al., 2010), we examined the degree to which impulsivity predicted smoking severity and the presence of automatized smoking behaviors. Detailed analysis was performed with respect to the BIS-11 scale and its subscales and specific self-reported symptoms of nicotine dependence using the Diagnostic and Statistical Manual's (*DSM-IV*) criteria for dependence. We predicted that impulsivity would be linked to the constructs of nicotine dependence most indicative of automaticity and the transition to habit rather than with markers of dependence, such as tolerance or withdrawal symptoms. Specifically, the two *DSM* symptoms that we felt most accurately reflected the concept of habit were Numbers 5 and 7, reflecting chain smoking and continued use despite health problems respectively.

Methods

Participants

Data from participants who had participated in studies in which smokers were recruited in our laboratory between 2007 and 2010 were compiled. Each study received ethical approval from the University of Nottingham Ethics Committee, and participants provided signed consent before each study. Participants were only included in the present analysis if they were aged between 18 and 25 years: A very small number of individuals in the entire dataset were 26 years or older and were excluded to create a well-defined age distribution in the range of interest.

Questionnaires

Data included in our analysis were obtained from self-report questionnaires, which were obtained under similar laboratory circumstances in each individual study. All measures were obtained on the same testing session.

Diagnostic and Statistical Manual

This questionnaire was made up of the module of questions concerning tobacco use within the alcohol use disorder and associated disabilities interview schedule-IV (AUDADIS-IV; Donny & Dierker, 2007; Grant et al., 2003). Seven criteria could be endorsed, which reflected the experience of a symptom within the participant's lifetime: tolerance (*DSM1*), withdrawal (*DSM2*), increase in use (*DSM3*), difficulty cutting down (*DSM4*), activities to use, obtain, recover (chain smoking: *DSM5*), reducing nonsmoking activities (*DSM6*), and continued use in spite of problems (*DSM7*). Intra-class correlation coefficients of the scale with other measures of dependence and tobacco use are good to excellent (0.6–0.8).

Cigarette Dependence Scale-5

The cigarette dependence scale (Etter, Le Houezec, & Perneger, 2003) consists of five questions in which participants rated their level of tobacco addiction, cigarettes smoked per day, time to first cigarette in the morning, expected difficulty quitting, and expected craving following a few hours abstinence. The scales are scored on 5-point scales with total scores varying between

5 and 25. The test–retest reliability and Cronbach's alpha for the scale are $>.8$.

Assessment of Substance Misuse in Adolescence

The assessment of substance misuse in adolescence (ASMA) scale (Willner, 2000) assessed whether the individual had ever tried illicit drugs and eight further questions pertaining to drug use when alone, preoccupation with drugs, tolerance, and relief of withdrawal/negative affect (range of scale = 0–9, where *never tried* = 0, *tried* = 1 + number of questions endorsed). The scale has a Cronbach's alpha of .90–.98.

Barratt Impulsiveness Scale-11

The BIS-11, consisting of 30 questions scored on a 1–4 scale, is a commonly used psychometric tool assessing different types of impulsivity on three main subscales: Attention (Att), Motor (Mot), and Non-planning (NP; Patton et al., 1995). Total BIS-11 score is the sum of the subscale scores.

Data Analysis

We assessed the association between BIS-11 data (independent measure) and various measures of drug use (dependent measure). The majority of dependent variables were skewed, so Spearman's ρ was used as a nonparametric estimate of the correlation coefficient. Significance of the associations of various measures of nicotine dependence with impulsivity was assessed using a Bonferroni-corrected alpha level. A second analysis was performed in which logistic regression was used to predict the endorsement of symptoms of the *DSM* scale. An uncorrected alpha level of .05 was used for the logistic regression analysis for hypothesis testing.

Results

Demographic Information and Descriptive Statistics

A dataset of 404 cases were analyzed in the present study. Of the participants, 204 (50.5%) were male and 200 (49.5%) were female. One hundred and eighty-five (45.8) were daily smokers (smoking 7 days per week), and the remaining participants (54.2%) were nondaily smokers. Smoking one (12.6% of the entire sample) or two (13.9% of the entire sample) days per week was most common in the latter group. Within the daily smoking group, 70.3% smoked 5 or more cigarettes a day, while 26.5% smoked 10 or more.

Means and *SDs* of questionnaire data are present in Table 1. Cronbach's alpha values for the BIS-11 scale were comparable with the expected range of these values (BIS-Total 0.81; BIS-Att 0.70; BIS-Mot 0.65; and BIS-NP 0.60; Stanford et al., 2009). Compared with normative values of the BIS-11 (Stanford et al., 2009), the population mean of BIS-11 scores was high—just less than 1 *SD* above normative scores.

Association of BIS-11 With Measures of Dependence

We observed modest correlations between BIS-11 total score and its subscales with the measures of tobacco use, dependence and craving, and illegal drug use (Table 2). Although these were generally positive, only a small number reached a Bonferroni-corrected

Table 1. Dependent Measures Obtained From Smokers, Assessing Age, Time Smoking, Impulsivity (BIS-11), Measures of Nicotine Dependence (CDS-5 and DSM), Number of Cigarettes Smoked Per Day (Number), and Illicit Drug Use (ASMA)

Variable	<i>n</i>	<i>M</i>	<i>SD</i>
Age	404	20.90	1.45
Age of onset	404	16.66	2.44
Years smoked	404	4.37	2.24
Number	404	6.31	4.52
DSM total	404	4.68	1.52
CDS-5	404	11.051	4.41
ASMA	404	2.22	2.064
BIS-Total	404	70.18	10.73
BIS-Att	404	18.29	3.89
BIS-Mot	404	25.66	4.65
BIS-NP	404	26.23	5.034

Note. ASMA = Assessment of Substance Misuse in Adolescence; BIS = Barratt Impulsiveness Scale; CDS = Cigarette Dependence Scale; DSM = Diagnostic and Statistical Manual.

significance level of 0.0025. It was not the case that the relationship between smoking and impulsivity was determined by illegal drug use: A sub group of participants scoring 0 or 1 on the ASMA scale (*n* = 174) showed similar levels of associations between BIS-11 Total impulsivity score and measures of nicotine dependence.

Association of BIS-11 With DSM Symptoms

Consistent with our hypotheses, presence of both DSM5 and DSM7 symptoms was predicted by variation in total BIS-11 scores using logistic regression. Higher total BIS-11 scores led to an increased likelihood of endorsing the DSM5 (odds ratio [OR] = 1.030, 95% CI = 1.010–1.051, *df* = 1, *p* = .0035) and DSM7 symptom (OR = 1.029, 95% CI = 1.005–1.053, *df* = 1, *p* = .016). Of the three BIS-11 subscales, the DSM5 symptom was predicted by the motor subscale (OR = 1.098, 95% CI = 1.048–1.15, *df* = 1, *p* < .001) but not the other two subscales. Similarly,

the DSM7 symptom was predicted by motor (OR = 1.058, 95% CI = 1.003–1.12, *df* = 1, *p* = .038) and non-planning impulsivity (OR = 1.050, 95% CI = 1.00–1.10, *df* = 1, *p* = .047). None of the associations between total BIS-11 scores and other DSM symptoms reached significance at an alpha level of .05 (Figure 1).

Discussion

In the present study, we sought more clearly to characterize the association between impulsivity and drug use in a large group of individuals with varying levels of tobacco usage recruited from a predominantly student population. First, the population showed a very high level of impulsivity as measured by the Barratt Impulsiveness Scale (BIS-11: Patton et al., 1995; Stanford et al., 2009) The high level of impulsivity observed throughout the entire sample in the present study is comparable with previous studies of adult (Mitchell, 1999) and adolescent smokers (Fields, Collins, Leraas, & Reynolds, 2009; Reynolds et al., 2007), a variety of different illegal drug user populations (Stanford et al., 2009) and somewhat consistent with aspects of personality in chippers (Kassel, Shiffman, Gnys, Paty, & Zettler-Segal, 1994).

Second, consistent with studies in experimental animals (Belin et al., 2008) and our observations with humans smokers (Hogarth et al., 2010; Hogarth, 2011), BIS-11 scores significantly predicted the presence of two symptoms of tobacco dependence (DSM5 and DSM7), which might be reflective of habitual smoking behavior. DSM5 was assessed by the endorsement of finding oneself chain smoking or similar. Although chain smoking might reflect a heightened incentive value of cigarettes, we suspect, due to the emphasis of the phrase “find yourself” in the question, that smoking might be automatized in individuals who endorse this symptom. DSM7 reflects continued smoking despite health problems or other negative consequences, such as depression or anxiety. Again, endorsement of such a symptom is suggestive of an inflexible relationship between consumption and the current value of the drug and accords the observation that impulsivity is associated with perseveration of drug self-administration despite shock punishment in rodents (Belin et al., 2008; Economidou, Pelloux, Robbins, Dalley, & Everitt, 2009). Nevertheless, the negative consequences of drug seeking are manifest within this paradigm (discrete and immediate) somewhat differently to how a smoker might experience them (typically sustained and slower). Both future human

Table 2. Measures of Association (Spearman’s ρ and accompanying *p* values) Between BIS-11 Impulsivity Scales and Measures of Nicotine Dependence (CDS-5 and DSM), Number of Cigarettes Smoked Per Day (Number), Days Smoking Per Week (Days), and Illicit Drug Use (ASMA)

Questionnaire	BIS-Total ρ, <i>p</i> value	BIS-Att ρ, <i>p</i> value	BIS-Mot ρ, <i>p</i> value	BIS-NP ρ, <i>p</i> value
CDS-5	0.13 (.009)*	−0.011 (.84)	0.13 (.007)*	0.17 (.001)**
DSM total	0.17 (.001)**	0.034 (.50)	0.22 (<.001)**	0.12 (.014)*
ASMA	0.14 (.004)*	0.033 (.51)	0.15 (.002)**	0.11 (.025)*
Days	0.075 (.14)	−0.035 (.49)	0.094 (.059)	0.11 (.029)*
Number	0.096 (.054)	−0.091 (.068)	0.16 (.001)**	0.13 (.010)*

Note. Double-starred coefficients reflect significant associations at a Bonferroni-corrected alpha level (.05/20 = .0025), while single-starred correlations were significant at an uncorrected or false discovery rate-corrected level. ASMA = Assessment of Substance Misuse in Adolescence; BIS = Barratt Impulsiveness Scale; CDS = Cigarette Dependence Scale; DSM = Diagnostic and Statistical Manual.

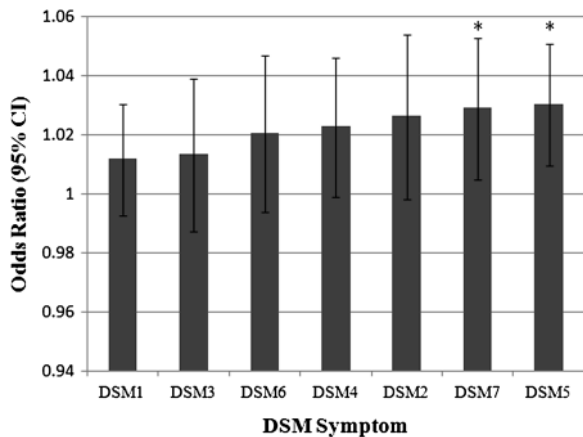


Figure 1. Odds ratios (ORs), which reflect the magnitude of the effect of BIS total score on likelihood of endorsement of a Diagnostic and Statistical Manual (DSM) symptom, are displayed. ORs are ordered by their magnitude, and stars represent significant regression coefficients. Error bars reflect the 95% CI of the observed OR. The following symptoms were measured: tolerance (DSM1), withdrawal (DSM2), increase in use (DSM3), difficulty cutting down (DSM4), activities to use, obtain, recover (chain smoking: DSM5), reducing nonsmoking activities (DSM6), and continued use in spite of problems (DSM7).

and animal work might attempt to identify the range of negative consequences to which drug seeking is insensitive.

However, the notion that impulsivity might also influence the rewarding aspects of nicotine is not ruled out by our findings. In particular, we also observed that BIS-11 scores showed modest but significant associations with a variety of measures of tobacco use and dependence (see also Spillane, Smith, & Kahler, 2010). Furthermore, it is possible that aspects of chain smoking and/or perseverative drug use might also reflect heightened drug reward. Another limitation of the study is that the BIS-11 likely reflects trait impulsivity, which itself has an uncertain relationship with other measures of the construct including inhibitory control or delay discounting, and the degree to which our findings are specific to the BIS-11 deserves further examination.

Summary

We observed that impulsivity was particularly predictive of the endorsement of symptoms of dependence suggestive of the development of automatized or habitual smoking. These data support the view that impulsivity plays a role in hastening the transition to habitual nonintentional control over drug seeking and hence the clinical perseveration of this behavior.

Funding

This work was supported by a Medical Research Council grant (number G0701456; LH).

Declaration of Interests

None declared.

Acknowledgments

Thanks to Amy Inman for assistance with data input and Nadja Heym for comments on the manuscript.

References

Audrain-McGovern, J., Rodriguez, D., Epstein, L. H., Cuevas, J., Rodgers, K., & Wileyto, E. P. (2009). Does delay discounting play an etiological role in smoking or is it a consequence of smoking? *Drug and Alcohol Dependence, 103*, 99–106. doi:S0376-8716(09)00105-7

Belin, D., Mar, A. C., Dalley, J. W., Robbins, T. W., & Everitt, B. J. (2008). High impulsivity predicts the switch to compulsive cocaine-taking. *Science, 320*, 1352–1355. doi:320/5881/1352

Coggins, C. R., Murrelle, E. L., Carchman, R. A., & Heidbreder, C. (2009). Light and intermittent cigarette smokers: A review (1989–2009). *Psychopharmacology (Berlin), 207*, 343–363. doi:10.1007/s00213-009-1675-4

Dalley, J. W., Fryer, T. D., Brichard, L., Robinson, E. S., Theobald, D. E., Laane, K., et al. (2007). Nucleus accumbens D2/3 receptors predict trait impulsivity and cocaine reinforcement. *Science, 315*, 1267–1270. doi:315/5816/1267

Diergaarde, L., Pattij, T., Poortvliet, I., Hogenboom, F., de Vries, W., Schoffelmeer, A. N., et al. (2008). Impulsive choice and impulsive action predict vulnerability to distinct stages of nicotine seeking in rats. *Biological Psychiatry, 63*, 301–308. doi:S0006-3223(07)00673-7

Donny, E. C., & Dierker, L. C. (2007). The absence of DSM-IV nicotine dependence in moderate-to-heavy daily smokers. *Drug and Alcohol Dependence, 89*, 93–96. doi:10.1016/j.drugalcdep.2006.11.019

Doran, N., McChargue, D., & Cohen, L. (2007). Impulsivity and the reinforcing value of cigarette smoking. *Addictive Behaviors, 32*, 90–98. doi:S0306-4603(06)00093-1

Economidou, D., Pelloux, Y., Robbins, T. W., Dalley, J. W., & Everitt, B. J. (2009). High impulsivity predicts relapse to cocaine-seeking after punishment-induced abstinence. *Biological Psychiatry, 65*, 851–856. doi:S0006-3223(08)01589-8

Etter, J. F., Le Houezec, J., & Perneger, T. V. (2003). A self-administered questionnaire to measure dependence on cigarettes: The Cigarette Dependence Scale. *Neuropsychopharmacology, 28*, 359–370. doi:10.1038/sj.npp.1300030

Fields, S., Collins, C., Leraas, K., & Reynolds, B. (2009). Dimensions of impulsive behavior in adolescent smokers and nonsmokers. *Experimental and Clinical Psychopharmacology, 17*, 302–311. doi:2009-17802-003

Flory, J. D., & Manuck, S. B. (2009). Impulsiveness and cigarette smoking. *Psychosomatic Medicine, 71*, 431–437. doi:PSY.0b013e3181988c2d

Grant, B. F., Dawson, D. A., Stinson, F. S., Chou, P. S., Kay, W., & Pickering, R. (2003). The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): Reliability

- of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. *Drug and Alcohol Dependence*, 71, 7–16. doi:10.1016/S0376-8716(03)00070-X
- Hogarth, L. (2011). The role of impulsivity in the aetiology of drug dependence: Reward sensitivity versus automaticity. *Psychopharmacology*, 215, 567–580. doi:10.1007/s00213-011-2172-0
- Hogarth, L., & Chase, H. W. (in press). Parallel goal-directed and habitual control of human drug-seeking: Implications for dependence vulnerability. *Journal of Experimental Psychology: Animal Behavior Processes*. doi:10.1037/a0022913
- Hogarth, L., Chase, H. W., & Baess, K. (2010). Impaired goal-directed behavioural control in human impulsivity. *Quarterly Journal of Experimental Psychology (Colchester)*, 10, 1–12. doi:929555795
- Kassel, J. D., Shiffman, S., Gnys, M., Paty, J., & Zettler-Segal, M. (1994). Psychosocial and personality differences in chippers and regular smokers. *Addictive Behaviors*, 19, 565–575. doi:10.1016/0306-4603(94)90012-4
- Mitchell, S. H. (1999). Measures of impulsivity in cigarette smokers and non-smokers. *Psychopharmacology (Berlin)*, 146, 455–464. doi:91460455.213
- Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology*, 51, 768–774. doi:10.1002/1097-4679(199511)51:6<768::AID-JCLP2270510607>3.0.CO;2-1
- Perkins, K. A., Lerman, C., Coddington, S. B., Jetton, C., Karelitz, J. L., & Scott, J. A. (2008). Initial nicotine sensitivity in humans as a function of impulsivity. *Psychopharmacology (Berlin)*, 200, 529–544. doi:10.1007/s00213-008-1231-7
- Powell, J., Dawkins, L., West, R., Powell, J., & Pickering, A. (2010). Relapse to smoking during unaided cessation: Clinical, cognitive and motivational predictors. *Psychopharmacology (Berlin)*, 212, 537–549. doi:10.1007/s00213-010-1975-8
- Reynolds, B., Patak, M., Shroff, P., Penfold, R. B., Melanko, S., & Duhig, A. M. (2007). Laboratory and self-report assessments of impulsive behavior in adolescent daily smokers and non-smokers. *Experimental and Clinical Psychopharmacology*, 15, 264–271. doi:2007-08187-006
- Shiffman, S. (1989). Tobacco “chippers”—Individual differences in tobacco dependence. *Psychopharmacology (Berlin)*, 97, 539–547. doi:10.1007/BF00439561
- Spillane, N. S., Smith, G. T., & Kahler, C. W. (2010). Impulsivity-like traits and smoking behavior in college students. *Addictive Behaviors*, 35, 700–705. doi:10.1016/j.addbeh.2010.03.008
- Stanford, M. S., Mathias, C. W., Dougherty, D. M., Lake, S. L., Anderson, N. E., & Patton, J. H. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences*, 47, 385–395. doi:10.1016/j.paid.2009.04.008
- Vanderschuren, L. J., & Everitt, B. J. (2004). Drug seeking becomes compulsive after prolonged cocaine self-administration. *Science*, 305, 1017–1019. doi:10.1126/science.1098975 305/5686/1017
- Verdejo-Garcia, A., Lawrence, A. J., & Clark, L. (2008). Impulsivity as a vulnerability marker for substance-use disorders: Review of findings from high-risk research, problem gamblers and genetic association studies. *Neuroscience and Biobehavioral Reviews*, 32, 777–810. doi:S0149-7634(08)00006-7
- Willner, P. (2000). Further validation and development of a screening instrument for the assessment of substance misuse in adolescents. *Addiction*, 95, 1691–1698. doi:10.1080/09652140020000920