

## Clinical correlates of tobacco smoking in OCD: A UK, case-controlled, exploratory analysis

PUNITA SHARMA<sup>1\*</sup>, TIM M. GALE<sup>2,3</sup> and NAOMI A. FINEBERG<sup>2,3,4</sup>

<sup>1</sup>Mott House Specialist Rehab Unit, West London Mental Health NHS Trust, Southall UB1 3EU, UK

<sup>2</sup>National OCDs Service, Hertfordshire Partnership NHS Foundation Trust, Queen Elizabeth II Hospital, Welwyn Garden City, AL74HQ UK

<sup>3</sup>University of Hertfordshire, College Lane, Hatfield, Herts, UK

<sup>4</sup>Cambridge University School of Clinical Medicine, Addenbrookes Hospital, Cambridge, UK

(Received: May 29, 2012; revised manuscript received: August 12, 2012; accepted: August 18, 2012)

*Background:* Obsessive–compulsive disorder (OCD) is a biologically heterogeneous neuropsychiatric disorder. It is associated with impulsive as well as compulsive neurocognitive mechanisms. Cigarette smoking is common among most psychiatric patients; however, OCD patients are thought to show reduced rates. OCD smokers may thus represent a relatively uncommon OCD subtype, characterised by increased impulsivity. In this study, we aim to establish the prevalence of smoking in a large, well-defined OCD cohort. We investigate whether smokers with OCD differ from non-smokers with OCD on clinical measures of behavioural impulsivity and domains of personality and temperament, including reward-dependence and novelty-seeking. *Method:* 183 of 200 outpatients with DSM-IV OCD were interviewed to determine smoking status. A sub-sample of 10 smokers was compared with 10 non-smokers, pair wise matched for age and gender. Patients were assessed for DSM co-morbidity, symptom profile, OCD severity, behavioural impulsivity and personality dimensions. *Results:* Only 10 individuals (5.46%; five males) were smokers. Compared to OCD non-smokers, OCD smokers scored significantly higher on the Barratt Impulsiveness Scale ( $p < 0.001$ ). They also scored significantly higher on TCI measures of novelty seeking ( $p < 0.001$ ) and reward dependence ( $p < 0.001$ ) and significantly lower on measures of harm avoidance ( $p < 0.001$ ). *Conclusions:* Tobacco smoking is rare in OCD. Significantly higher levels of behavioural impulsivity and temperamental factors associated with reward driven impulsivity are seen in OCD smokers compared to non-smokers. Tobacco smoking may indicate a possible source of neurocognitive heterogeneity in OCD.

**Keywords:** OCD, smoking, tobacco, nicotine, behavioural impulsivity, harm avoidance

### INTRODUCTION

Tobacco smoking is a leading behavioural health problem and constitutes a prime cause of preventable premature death. Approximately 21% of the UK population aged 16 years and over are smokers (General Household Survey, 2007). Tobacco smoking is more prevalent among psychiatric patients than the general population (Amering et al., 1999; Breslau, 1995; Breslau, Kilbey & Andreski, 1991; Glassman, 1993; Hughes, Hatsukami, Mitchell & Dahlgren, 1986) and is particularly common among those with schizophrenia, where the prevalence is extremely high (74%–88%) compared with patients with other psychiatric diagnoses (45% to 70%) (Bejerot & Humble, 1999). Five studies have examined tobacco smoking in individuals with anxiety disorders including OCD (Baker-Morissette, Gulliver, Wiegel & Barlow, 2004; Bejerot & Humble, 1999; Himle, Thyer & Fischer, 1988; McCabe et al., 2004). Of these, only one study (Bejerot & Humble, 1999) specifically investigated smoking habits among patients with OCD. According to the published studies, the prevalence of smoking among patients with OCD appears to be low (7.7%–22.4%), compared to other anxiety disorders and to psychiatric disorders in general. It has been suggested that the lower occurrence of smoking in OCD could be related to psychological, social or medical factors. Thus, a low rate of smoking amongst OCD patients may reflect constitutional factors that underpin

risk-avoidant behaviour in general. Alternatively, specific symptoms intrinsic to the disorder, such as fear of bodily harm and disease, parsimony or fear of causing a fire, may deter individuals from smoking. Additionally, people with OCD may be less socially integrated in early life, e.g. more isolated at school, and therefore less susceptible to peer-pressure to smoke, compared with their more socially competent counterparts. An independent genetic factor making smoking less rewarding, possibly related to the cholinergic system, has also been proposed (Bejerot & Humble, 1999).

### AIMS

We investigated the possible link between tobacco smoking and OCD by surveying attendees at a UK specialist OCD outpatient clinic. Patients' diagnoses were clearly established and there was a range of illness severity and complexity. Our primary hypotheses were that (1) the prevalence of smoking in patients with DSM-IV OCD attending the clinic

\* Corresponding author: Dr P. Sharma, Mott House Specialist Rehab Unit, West London Mental Health NHS Trust, Uxbridge Road, Southall UB1 3EU, UK; E-mail: drpunitasharma@yahoo.com

would be low relative to population norms, and (2) OCD smokers would be distinguishable from their non-smoking counterparts in terms of clinical factors such as increased levels of behavioural impulsivity; temperament and character differences including decreased harm avoidance and increased reward dependence; increased childhood psychosocial maladjustment; increased OCD symptom-severity; fewer OCD symptoms linked to harm; and increased DSM-IV Axis I and II comorbidity.

## METHOD

The study was approved by the Hertfordshire Research Ethics Committee. Consecutive patients attending the Hertfordshire Partnership NHS Foundation Trust Specialist OCD Service were approached at the end of the clinic appointment. In addition, all past patients on the records for the last five years were invited to attend an assessment at the Department. All participants gave written informed consent and were allowed time with an investigator to address any queries. All study participants met the DSM-IV criteria for OCD using the Mini International Neuropsychiatric Inventory – MINI (Sheehan et al., 1998) supported by an extended clinical interview with an expert clinician. In addition, for inclusion, OCD needed to be the principal focus of clinical attention, or in the case of past patients, the priority for previous treatment. Comorbidity was not excluded; instead comorbid DSM disorders were assessed and noted from the extended clinical interview.

Based upon a conservative estimate that 5–10% of OCD patients would be smokers (Bejerot & Humble, 1999), 200 patients with OCD were approached. Out of these, 183 agreed to participate and attended a face-to-face interview. All participants were assessed for current and previous smoking habits, including numbers of cigarettes smoked daily, on a questionnaire devised for the purpose (available on request) as well as demographic variables such as age, gender; age of onset of illness, current medication and severity of illness using standardised instruments.

The subsample of smokers ( $n = 10$ ) and 10 non-smokers (who had never smoked), derived from the same cohort and selected using frequency matching, adjusting as closely as possible for age and gender, were invited for a second visit. The ‘case-control’ samples were rated for DSM-IV comorbidity using the Mini International Neuropsychiatric Inventory – MINI (Sheehan et al., 1998); symptom profiles using the Dimensional Yale–Brown Obsessive Compulsive Scale – DYBOCS (Rosario-Campos et al., 2006); severity of OCD using the Yale–Brown Obsessive Compulsive Scale – YBOCS (Goodman et al., 1989); depression using the Montgomery and Asberg Depression Rating Scale – MADRS (Montgomery & Asberg, 1979); behavioural impulsivity using the Barrett Impulsiveness Scale – BIS (Patton, Stanford & Barratt, 1995); temperament and character using the Cloninger Temperament and Character Inventory – TCI (Cloninger, 1994); global severity of illness using the Clinical Global Impression-Severity Scale – CGI-S (Guy, 2000); social adjustment using the Life Status Review (Stamm & Rudolph, 1996) and obsessive–compulsive personality profile using the Compulsive Personality Assessment Scale – CPAS (Anseau, 1996).

OCD smokers and non-smokers were compared on these variables using statistical tests derived from IBM SPSS (Statistical Package for the Social Sciences). Continuous vari-

ables were compared with *t*-tests and proportions were compared using Chi-Square (or Fisher’s exact test, when cell counts were low). We additionally corrected for multiple testing; as there were 10 different measures, the significance level was set at  $p = 0.005$ .

## RESULTS

Among 183 OCD patients assessed (78 males, 105 females), all responded to questions about smoking habits. Both current and previous smoking status was addressed. Current smoking was defined as consumption of at least one cigarette daily for the previous 3–6 months. Only 10 (5.46%; 5M:5F) were current smokers. For the purposes of our analysis, these were considered to be the ‘OCD smokers’. Tobacco consumption varied from 0–22 smoking pack years, ranging from two cigarettes per day for less than a year to 30 cigarettes per day for 20 years. Most of the OCD smokers had concomitant mental disorders; four had major depressive disorder while three had generalised anxiety disorder. All the OCD smokers reported that smoking tobacco provided some relief from their OCD symptoms. One-hundred and sixty-eight (91.8%) of the patients had never smoked while five previous smokers had stopped without any major difficulties. The most common reason given for never starting smoking was simply lack of any interest in trying it. The reasons for quitting smoking were predominantly “Had enough of it” and “Was expensive”.

Table 1 compares the ten OCD smokers with the subsample of ten OCD non-smokers on the clinical test variables. For each clinical test, a linear regression model was run using the 3 predictor variables – smoking status, age and gender. We determined the effect size (smokers vs. non-smokers) for each test and, given the small sample size in this study, we also determined the minimum sample size required for non-significant effect sizes to become significant ( $\alpha = 0.05$ ,  $\beta = 0.1$ ). These are reported in Table 1.

OCD smokers and OCD non-smokers differed on several clinical measures. Smokers were significantly more impulsive than non-smokers on the Barrett Impulsiveness Scale (82.20,  $SD = 10.1$ ) vs. (62.50,  $SD = 9.1$ )  $p < 0.001$ . They also scored significantly higher on TCI measures of novelty seeking (33.70,  $SD = 6.3$ ) vs. (18.80,  $SD = 4.9$ ),  $p < 0.001$  and reward dependence (13.40,  $SD = 3.8$ ) vs. (7.50,  $SD = 2.4$ );  $p < 0.001$  and significantly lower on measures of harm avoidance (10.90,  $SD = 3.9$ ) vs. (23.80,  $SD = 5.9$ )  $p < 0.001$ . In addition, the smokers showed reduced TCI-persistence (25.50,  $SD = 4.9$ ) vs. (31.20,  $SD = 7.1$ )  $p < 0.02$ .

In contrast, there were no significant differences between the OCD smokers and non-smokers in the severity of OCD; comorbidity rates; social adjustment measures; obsessive compulsive personality profile, and other character variables including self-directedness, cooperativeness and self-transcendence. Specifically, comorbid anxiety, depressive disorder and a past history of depression were all common among the smokers, but without attaining statistical significance, possibly owing to small numbers within the test groups (see Table 1 for effect sizes and minimum sample sizes required for significance).

Regarding response to treatment; there were no significant differences in the number of previous treatments, clinical response to SSRI medication, use of antipsychotic augmentation or duration of attendance at the OCD clinic.

Table 1. Clinical variables in OCD smokers and OCD non-smokers: comparison of means (*t*-test for Equality of Means)

Variable	Smoking status	<i>N</i>	Mean	<i>SD</i>	Sig (2-tailed)	Effect size	Min. sample size (per group)
CPAS	Smoker	10	23.50	3.80	.090	.36	44
	Non-Smoker	10	21.20	1.87			
CGI-S	Smoker	10	4.00	1.05	.573	.12	122
	Non-Smoker	10	3.80	.42			
CGI-I	Smoker	10	2.80	.78	.394	.19	79
	Non-Smoker	10	3.10	.73			
MADRS	Smoker	10	36.80	9.61	.172	.32	49
	Non-Smoker	10	30.80	8.23			
BIS	Smoker	10	82.20	10.17	.001	.71	
	Non-Smoker	10	62.50	9.15			
Y-BOCS	Smoker	10	12.50	2.63	.128	.21	72
	Non-Smoker	10	11.40	2.45			
TCI-NS	Smoker	10	33.70	6.34	.001	.79	
	Non-Smoker	10	18.80	4.96			
TCI-HA	Smoker	10	10.90	3.95	.001	.79	
	Non-Smoker	10	23.80	5.99			
TCI-RD	Smoker	10	13.40	3.86	.001	.68	
	Non-Smoker	10	7.50	2.41			
TCI-PE	Smoker	10	25.50	4.90	.017	.42	
	Non-Smoker	10	31.20	7.17			
TCI-SD	Smoker	10	32.30	8.55	.153	.29	53
	Non-Smoker	10	27.80	6.28			
TCI-CO	Smoker	10	14.30	5.18	.60	.12	122
	Non-Smoker	10	13.10	4.72			
TCI-ST	Smoker	10	10.60	3.37	.79	.06	239
	Non-Smoker	10	10.20	2.82			

Note: CPAS – Compulsive Personality Assessment Scale; CGI – Clinical Global Impression; MADRS – Montgomery Asberg Depression Rating Scale; BIS – Barratt Impulsiveness Scale; Y-BOCS – Yale–Brown Obsessive Compulsive Scale; TCI-NS – Temperament and Character Inventory–Novelty Seeking; TCI-HA – Harm Avoidance; TCI-RD – Reward Dependence; TCI-PE – Persistence; TCI-SD – Self Directedness; TCI-CO – Cooperativeness; TCI-ST – Self-Transcendence

We formed an impression from surveying the case-notes that the OCD smokers had poorer clinic attendance records, resulting in them dropping out of the treatment after fewer sessions when compared to the OCD non-smokers. However, as attendance was not specifically tested for, we were not able to quantify this.

## DISCUSSION

Our results suggest that OCD is associated with reduced tobacco smoking compared to population norms. The frequency of OCD smokers identified in our study (5.46%) was low even compared to rates previously reported in the literature (Table 2). This is relevant since we believe our study investigated the largest number (200) of OCD outpatients. Cultural factors may influence rates of substance abuse which can differ substantially across countries (Piko, Luszczynska, Gibbons & Tekozel, 2004). Our findings extend the results of Bejerot and Humble (1999) in a Swedish sample and suggest a strikingly low prevalence of tobacco-smoking among treatment-seeking UK OCD patients. They are also consistent with the results from a recent large-scale US family-based case-control study that was unable to show a specific association between OCD and substance abuse (Wittchen et al., 2011). Our finding implies that the presence of OCD may have a protective effect against smoking. We may also infer that a small subgroup of OCD patients, characterised by high levels of reward impulsivity,

is particularly susceptible to tobacco smoking and possibly also to the pharmacological effects of nicotine.

Certain characteristics of temperament and behavioural propensities have been linked to patients with substance abuse disorders; the most salient variables being high novelty-seeking (Cloninger, 1987; Zuckerman, 1983) and impulsivity (Chiara, 2000) and low harm avoidance (Khan, 2005; Le Bon, 2004). In our study, OCD smokers were distinguishable from OCD non-smokers in terms of higher scores on the BIS, TCI reward dependence and novelty seeking scales and lower scores on the TCI harm avoidance scales. These findings are consistent with behavioural and temperamental correlates of greater 'reward-driven' impulsivity (Padhi, Mehdi, Craig & Fineberg, 2010). Reward-driven impulsivity has previously been found to predict tobacco smoking and other substance and behavioural addictions (Koob & Le Moal, 2001; Poulos, Le & Parker, 1995). In contrast, OCD has been shown to be associated with increased harm avoidance and lower self-directedness and cooperativeness on the TCI (Cruz-Fuentes, Blas, Gonzalez, Camarena & Nicolini, 2004). It would thus appear that relatively elevated scores on the BIS, TCI Reward Dependence scale and TCI Novelty Seeking scale and reduced scores on the TCI Harm Avoidance scales are associated with the expression of smoking behaviour within the OCD population. In the absence of a healthy control group, our study was unable to determine whether OCD smokers as a group show an abnormally increased propensity toward reward-impulsivity and/or OCD non-smokers show abnormally reduced re-

Table 2. Comparative frequency of smoking in OCD: a systematic review of studies investigating OCD (including the current study)

Study	Sample size	Principal diagnosis	Percentage smokers (%)
Bejerot & Humble (1999)	<i>n</i> = 83	Clinical OCD	14.5
		OCD association group	13.8
		Psychiatric outpatient group (non-OCD)	42.0
		National normative sample (1991)	25.4
Baker-Morissette et al. (2004)	<i>n</i> = 581	Panic disorder with/without agoraphobia and agoraphobia without panic	19.2
		GAD	17.2
		Social phobia	13.6
		Specific phobia	5.0
		OCD	7.7
		PTSD	0
		Anxiety disorder not otherwise specified	4.6
		MDD	25.0
		Total	14.9
McCabe et al. (2004)	<i>n</i> = 155	Panic disorder	40.4
		Social phobia	19.6
		OCD	22.4
Himle et al. (2004)	<i>n</i> = 163	Simple phobia	47
		Social phobia	27
		Agoraphobia	57
		Panic disorder	47
		GAD	29
		OCD	9
Sharma et al. (2012 – this paper)	<i>n</i> = 183	OCD	5.46

Note: OCD – Obsessive-compulsive disorder; PTSD – Post-traumatic stress disorder; GAD – Generalised anxiety disorder; MDD – Major depressive disorder

ward-impulsivity. Notwithstanding, smoking status appears to act as a marker of clinical heterogeneity within the domain of impulsivity in OCD patients and a possible source of confound in neurocognitive studies of compulsive/impulsive behavior within this patient-group.

Impulsivity is thought to be multidimensional and may be fractionated into neuropsychologically distinct components mediated by overlapping as well as distinct neural substrates (Fineberg et al., 2010). Neurocognitive and brain-imaging studies have demonstrated that problems inhibiting preplanned motor actions on laboratory tasks i.e. ‘motor impulsivity’, mediated by activation within cortico-striatal neurocircuitry, acts as vulnerability factor for OCD (Menzies et al., 2007). In contrast, substance addiction is associated with reward-driven impulsivity and abnormal ventral reward circuitry (Fineberg et al., 2010). Serotonin and dopamine interact across these circuits to modulate aspects of both impulsive and compulsive responding and as yet unidentified brain-based systems may also have important functions (Fineberg et al., 2010).

OCD compulsions are traditionally viewed as behaviours designed to avert harmful consequences, and harm-avoidance has been hypothesized to be a relevant psychological factor in the aetiology of OCD (Cruz-Fuentes et al.,

2004). Interestingly, in our study samples, the magnitude of clinical impulsivity, and TCI reward dependence and harm avoidance, did not appear to influence the phenomenological presentation of OCD. Specifically, despite significant between-group differences in these measures, OCD smokers were indistinguishable from non-smokers on key clinical parameters including OCD symptom-profile (Y-BOCS checklist), symptom-severity (Y-BOCS obsession, compulsion and total score), psychiatric comorbidity, social adjustment (Life Status Review) and obsessive compulsive personality profile (CPAS). Our findings hint, therefore, that reward-driven impulsivity does not directly impact upon the clinical expression of OCD and, perhaps controversially, question the role of harm avoidance and reward dependence mechanisms as relevant factors in the generation of OCD symptomatology. However, it is important to acknowledge that the small numbers in our sample may have obscured relevant differences.

In our sample of OCD smokers, nicotine was subjectively experienced as anti-obsessional. Dopamine pathways in the mesolimbic system have an important function in reward and reinforcement (Wise, 2002). Nicotine depends on dopamine-release for those behavioural effects that are most relevant for its reinforcing properties (Chiara, 2000). It is possible that smoking-induced dopamine release produces a temporary anti-obsessional, or hedonic effect that patients with OCD find therapeutic. Preliminary results suggesting a positive effect for placebo-controlled single dose amphetamine challenge in OCD imply there may be a possible role for compounds modulating dopamine release as a therapeutic strategy (Pooley, Fineberg & Harrison, 2007). Our results suggest that further exploration of the clinical and neurocognitive effect of tobacco-smoking and dopaminergic modulation in OCD would be informative.

## LIMITATIONS

Our sample-size was necessarily small, and the results must be viewed as exploratory in nature, owing to the low frequency of smoking in the OCD population. Other factors aside from impulsivity and social adjustment, not tested in this study, may additionally play a role in the expression of smoking behaviour in OCD patients. For example, psychosocial factors such as life satisfaction, academic achievement, future orientedness and degree of social comparison have been found to correlate with smoking rates (Piko et al., 2004) across different countries and cultures and may act as mediating factors. Moreover this study was limited to UK participants. Larger multinational cohorts are required to advance our understanding of the role of tobacco-smoking in OCD.

## CONCLUSIONS

We may conclude that tobacco smoking is rare in OCD. OCD smokers appear to be distinguishable from their non-smoking counterparts by significantly higher self-reported behavioural impulsivity and temperamental factors associated with reward-driven impulsivity, coupled with lower levels of harm-avoidance.

## ACKNOWLEDGEMENTS

The authors would like to thank Professor Humberto Nicolini, Center for Genomic Sciences, Universidad Autónoma de la Ciudad de México and Carracci Medical Group for this advice on an earlier manuscript.

## REFERENCES

- Amering, M., Bankier, B., Berger, P., Griengi, H., Windhaber, J. & Katschnig, H. (1999). Panic disorder and cigarette smoking behaviour. *Comprehensive Psychiatry*, *40*, 35–38.
- Ansseau, M. (1996). Serotonergic antidepressants in obsessive personality (NR198). In: *149<sup>th</sup> Annual Meeting of the American Psychiatric Association*. New York, NY: American Psychiatric Association, 121–122.
- Baker-Morissette, S. L., Gulliver, S. B., Wiegel, M. & Barlow, D. H. (2004). Prevalence of smoking in anxiety disorders complicated by comorbid alcohol or substance abuse. *Journal of Psychopathology and Behavioral Assessment*, *26*(2), 107–111.
- Bejerot, S. & Humble, M. (1999). Low prevalence of smoking among patients with obsessive–compulsive disorder. *Comprehensive Psychiatry*, *40*, 268–272.
- Bienvenu, O. J., Samuels, J. F., Wuyek, L. A., Liang, K. Y., Wang, Y., Grados, M. A. & Nestadt, G. (2012). Is obsessive–compulsive disorder an anxiety disorder, and what, if any, are spectrum conditions? A family study perspective. *Psychol. Med.*, *42*(1), 1–13.
- Breslau, N. (1995). Psychiatric comorbidity of smoking and nicotine dependence. *Behaviour Genetics*, *25*, 95–101.
- Breslau, N., Kilbey, M. & Andreski, P. (1991). Nicotine dependence, major depression, and anxiety in young adults. *Archives of General Psychiatry*, *48*, 1069–1074.
- Chiara, G. D. (2000). Role of dopamine in the behavioural actions of nicotine related to addiction. *European Journal of Pharmacology*, *393*(1–3), 295–314.
- Cloninger, C. R. (1987). A systematic method for clinical and description and classification of personality variant. *Arch. Gen. Psychiatry*, *44*, 584–587.
- Cloninger, C. R. (1994). *The temperament and character inventory (TCI): A guide to its development and use*. St. Louis, MO: Center for Psychobiology of Personality, Washington University.
- Cruz-Fuentes, C., Blas, C., Gonzalez, L., Camarena, B. & Nicolini, H. (2004). Severity of obsessive–compulsive symptoms is related to self-directedness character trait in obsessive–compulsive disorder. *CNS Spectr.*, *9*(8), 607–612.
- Fineberg, N. A., Potenza, M., Chamberlain, S. R., Berlin, H. A., Menzies, L., Bechara, A., Sahakian, B. J. & Hollander, E. (2010). Probing compulsive and impulsive behaviours, from animal models to endophenotypes: A narrative review. *Neuropsychopharmacology*, *35*(3), 591–604.
- General Household Survey. Smoking and drinking among adults, 2007. Office for National Statistics.
- Glassman, A. H. (1993). Cigarette smoking: Implications for psychiatric illness. *American Journal of Psychiatry*, *150*, 546–553.
- Goodman, W. K., Price, L. H., Rasmussen, S. A., Mazure, C., Fleischmann, R. L., Hill, C. L. & Charney, D. S. (1989). The Yale–Brown Obsessive Compulsive Scale. *Arch. Gen. Psychiatry*, *46*(11), 1006–1016.
- Guy, W. (2000). Clinical Global Impressions (CGI) Scale. Modified from: Rush, J. et al.: *Psychiatric Measures*. Washington DC: APA.
- Himle, J., Thyer, A. B. & Fischer, D. J. (1988). Prevalence of smoking among anxious outpatients. *Phobia Practice and Research Journal*, *1*(1), 25–31.
- Hughes, J. R., Hatsukami, D. K., Mitchell, J. E. & Dahlgren, L. A. (1986). Prevalence of smoking among psychiatric outpatients. *American Journal of Psychiatry*, *143*, 993–997.
- Khan, A. A., Jacobson, K. C., Gardner, C. O., Prescott, C. A. & Kendler, K. S. (2005). Personality and comorbidity of common psychiatric disorders. *British Journal of Psychiatry*, 190–196.
- Koob, G. F. & Le Moal, M. (2001). Drug addiction, dysregulation of reward, and allostasis. *Neuropsychopharmacology*, *24*(2), 97–129.
- Le Bon, O., Basiaux, P., Streel, E., Tecco, J., Hanak, C., Hansenne, M., Ansena, M., Pelc, I., Verbanck, P. & Dupont, S. (2004). Personality profile an drug of choice: A multivariate analysis using Cloninger’s TCI on heroin addicts, alcoholics, and a random population group. *Drug Alcohol Depend.*, *73*(2), 175–182.
- McCabe, R. E., Chudzik, S. M., Antony, M. M., Young, L., Swinson, R. P. & Zolvensky, M. J. (2004). Smoking behaviours across anxiety disorders. *Journal of Anxiety Disorders*, *18*, 7–18.
- Menzies, L., Achard, S., Chamberlain, S. R., Fineberg, N. A., Chen, C. H., Campo, N. D. & Bullmore, E. (2007). Neurocognitive endophenotypes of obsessive–compulsive disorder. *Brain*, *130*(12), 3223–3236.
- Montgomery, S. A. & Asberg, M. (1979). A new depression scale designed to be sensitive to change. *British Journal of Psychiatry*, *134*(4), 382–389.
- Padhi, A., Mehdi, A. M., Craig, K. & Fineberg, N. A. (2010). Current classification of impulse control disorders: Cognitive versus behavioral impulsivity and the role of personality. In: Potenza, M. N., Grant, J. E. (Eds.). *Oxford handbook of impulse control disorders*. Oxford: Oxford University Press.
- Patton, J. M., Stanford, M. S. & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology*, *51*, 768–774.
- Piko, B. F., Luszczynska, A., Gibbons, F. X. & Tekozel, M. (2004). A culture-based study of personal and social influences of adolescent smoking. *European Journal of Public Health*, *15*(4), 393–398.
- Pooley, E. C., Fineberg, N. A. & Harrison, P. J. (2007). The met<sup>158</sup> allele of catechol-O-methyltransferase (COMT) is associated with obsessive–compulsive disorder in men: Case-control study and meta-analysis. *Molecular Psychiatry*, *12*, 556–561.
- Poulos, C. X., Le, A. D. & Parker, J. L. (1995). Impulsivity predicts individual susceptibility to high levels of alcohol self-administration. *Behavioural Pharmacology*, *6*, 810–814.
- Rosario-Campos, M. C., Miguel, E. C., Quatrano, S., Chacon, P., Ferrao, Y., Findley, D. & Leckman, J. F. (2006). DYBOCS to assess different symptom profile. *Mol Psychiatry*, *11*(5), 495–504.
- Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E. & Dunbar, G. C. (1998). The MiniInternational Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J. Clin. Psychiatry*, *59*(20), 22–33.

- Stamm & Rudolph (1996–97). The Life Status Review to assess social adjustment – Loners versus friends.
- Wise, R. A. (2002). Brain reward circuitry: Insights from unsensed incentives. *Neuron*, 36, 229–240.
- Wittchen, H. U., Jacobi, F., Rehm, J., Gustavsson, A., Svensson, M., Jönsson, B. & Steinhausen, H.-C. (2011). The size and burden of mental disorders and other disorders of the brain in Europe 2010. *European Neuropsychopharmacology*, 21, 655–679.
- Zuckerman, M. (1983). Sensation seeking: The initial motive for drug abuse. In E. H. Gottheil, K. A. Druley, T. E. Skoloda & H. M. Waxman (Eds.), *Etiological aspects of alcohol and drug abuse* (pp. 202–220). Springfield, IL: Charles C. Thomas.