

Why does smoking so often produce dependence? A somewhat different view

John R Hughes

Abstract

The usual explanation for why smoking produces dependence focuses on the effects of nicotine on dopamine and other neurobiological explanations. This review offers four somewhat different explanations: (1) nicotine can offer several psychopharmacological benefits at the age when such benefits are especially needed; (2) cigarettes provide for a rapid, frequent, reliable and easy-to-obtain reward; (3) nicotine is not intoxicating, allowing chronic intake; and (4) the long duration of the nicotine withdrawal syndrome effectively undermines cessation. This article reviews the evidence for the above views and the tobacco control activities these views suggest.

(*Tobacco Control* 2001;10:62–64)

Keywords: nicotine; substance use disorder; substance withdrawal; tobacco use disorder

Many of us are asked by fellow scientists, administrators, clinicians, acquaintances, and tobacco lawyers why we think cigarette smoking produces dependence. The usual response often emphasises brain changes, genetics and other neurobiological explanations as described in the 1988 surgeon general's report.¹ The present article proposes four other factors that I and others believe are as important, to understanding nicotine dependence (in this paper "dependence" refers to the *Diagnostic and statistical manual of mental disorders*, fourth edition (DSM-IV) definition²). My views are not new; however, I believe they are much under appreciated both by tobacco control advocates and by biological scientists. Plus, I believe they suggest concrete changes in our tobacco control activities.

Nicotine, the "renaissance drug"

A common explanation of why nicotine and other drugs can be dependence producing focuses on how drugs increase dopamine and act on "reward centres" of the brain.^{1–3} Sometimes these explanations emphasise positive reinforcement (that is, pleasurable effects often termed euphoria) as the main cause of dependence.^{1–5} Other times they emphasise negative reinforcement—that is, smokers use cigarettes mostly to avoid withdrawal.^{3–7}

These explanations often give little emphasis to the possibility that nicotine induces dependence because it produces beneficial effects that can help smokers cope with their environment.^{8–9} By beneficial effects, I mean positive effects that are not due to relief of withdrawal but rather are effects above and beyond a "normal" baseline functioning.¹⁰

Whether nicotine via smoking causes true beneficial effects is, to many, debatable.^{8–11–12} My belief (and that of others before me^{8–9}) that nicotine can cause true beneficial effects is based on three sets of data. First, nicotine often causes improvements in animals with no history of nicotine exposure, in never smokers, and in non-deprived smokers.^{8–11} Second, most other drugs of dependence produce beneficial effects—for example, cocaine produces stimulation and alcohol produces relaxation and increased confidence. Third, the two other major explanations for nicotine dependence (euphoria and withdrawal relief) have problems explaining the persistence of smoking. Euphoria is endorsed only 10% of the time while smoking¹³ plus very few smokers report euphoria as a reason for smoking.¹⁴ Withdrawal is often reported by adolescents⁷; however, 77% of adolescents deny ever using cigarettes to avoid withdrawal symptoms.¹⁵ I am not denying euphoria or withdrawal occur; however, I believe they cannot adequately explain the persistence of smoking.

Nicotine's beneficial effects are probably especially potent in the transition from experimental to regular smoking. Nicotine can produce several diverse effects—that is, it can reduce aggression, improve focus on cognitive tasks, increase vigilance, decrease weight gain, and improve mood.¹⁶ These beneficial effects are probably especially appealing to teenagers. Consider the issues most teenagers are dealing with. Many are trying to control their aggression, to focus attention for long periods of time, to control their weight or to control their mood.⁶ Typically, they have trouble mastering these skills. When adolescents experiment with cigarettes, they may find that nicotine can help with some of these problems, plus it is likely to be a more reliable solution than their own fledgling skills. Although we have no direct tests of beneficial effects of nicotine in adolescents, it does seem likely that many adolescents come to use cigarettes as a

Department of
Psychiatry, University
of Vermont,
Burlington, Vermont,
USA
J R Hughes

Correspondence to:
John R Hughes MD,
Department of Psychiatry,
University of Vermont, 38
Fletcher Place, Burlington,
VT 05401–1419, USA
john.hughes.uvm.edu

Received 26 May 2000 and
in revised form
1 October 2000. Accepted 12
October 2000

multipurpose pharmacological coping strategy. Whether this use of cigarettes for beneficial effects persists and maintains smoking into adulthood or whether the motive for smoking changes to withdrawal relief is still unclear.

Rapid, frequent, reliable and easy-to-attain effects from nicotine via cigarettes

Many lay persons believe the magnitude of a reward is the most important determinant of its efficacy. In reality, the rapidity, frequency, reliability, and ease of attainment of the reward are as important, if not more important.¹⁷ I, and others before me,¹⁸ believe nicotine via cigarette smoking is so dependence producing because it maximises all four of these effects.

First, nicotine via cigarettes is absorbed via the lung, directly into the arterial system, without dilution of the venous system, and reaches the brain within 10 seconds.¹ This is faster than intravenous use. I know of few rewards that occur quicker. Second, if one smokes 20 cigarettes a day and takes 10 puffs per cigarette, this means 200 rewards per day. I know of no other reward that occurs so frequently in daily life. Third, unlike purchasing illicit drugs on the street in which the purity varies from sale to sale, with cigarettes, one gets exactly the same dose with each purchase. Fourth, because of ubiquitous marketing and underage sales, purchasing of cigarettes requires significantly less effort than purchasing illicit drugs or alcohol. Perhaps the best evidence for this view is that when nicotine is delivered via medications in which the delivery is slow, infrequent and costly (for example, transdermal nicotine), then the dependence potential of nicotine is low.^{3, 4}

Nicotine is not intoxicating

A common criticism of defining smoking as a nicotine dependence is that, unlike other drug dependencies, smoking does not cause intoxication and the related extreme behaviours (for example, crime or violence).¹⁹ I believe the lack of intoxication from nicotine makes it more addicting, not less addicting. This lack of intoxication allows the smoker to ingest large amounts of a drug without causing social problems, increasing the probability of experiencing beneficial effects or of physical dependence developing. In support of this notion, studies of other drug dependencies clearly indicate intoxication inhibits use in dependent users.²⁰ Also, many ever users of tobacco become daily users, but fewer ever users of alcohol and cocaine do so.^{21, 22} This is probably caused, in part, by the limiting effects of alcohol and cocaine intoxication.

In addition, I believe this lack of intoxication contributed to society's tacit acceptance of nicotine dependence. One can argue that much of society's response to drug dependence is based on concerns about how a drug user's actions will influence others. Since nicotine does not acutely disrupt families, cause violence, etc, it is easy to see how society would not have a pressing need to intervene or to label nicotine a drug of dependence.

Duration of nicotine withdrawal

To many lay persons, a severe withdrawal syndrome which produces physical changes is a central characteristic of a drug dependence. Although nicotine withdrawal can be severe in some smokers, in most smokers it is not.^{23, 24} I believe the reason nicotine withdrawal is important is not its severity but rather its duration.²⁴ Multiple studies have found that the average duration of withdrawal is about three weeks and that a substantial proportion of smokers ($\geq 40\%$) have withdrawal symptoms that last longer than three weeks.²⁴ I believe that it is this chronic, low grade discomfort that undermines smoking cessation. For example, chronic hunger undermines many attempts to lose weight, even though hunger on any one day may not be severe. In addition, I believe that many smokers who are still irritable, hungry, and anxious after three weeks believe this is how they will be for the rest of their life without cigarettes. Faced with this possibility, it is understandable why many smokers would relapse. Earlier studies that focused on the severity of withdrawal did not find withdrawal undermined cessation.²⁵ However, more sophisticated recent studies have found that abstinent smokers whose withdrawal abates slowly are much more likely to relapse than those whose withdrawal abates rapidly.²⁶ Thus, the evidence supports the notion that the duration of withdrawal is important.

Implications for tobacco control

These four particular features of nicotine dependence suggests possible changes in tobacco control activities. The major implication of the first view—nicotine has several beneficial effects—is that prevention programmes perhaps should stop denying this. Most smokers believe nicotine has beneficial effects.¹³ Denying such effects undermines the credibility of prevention programmes. We do not try to deny that cocaine stimulates or that alcohol is relaxing in prevention programmes, so why deny beneficial effects for nicotine? Admitting nicotine has beneficial effects can be integrated into prevention programmes by pointing out that smoking is sometimes a “pharmacological crutch”.

The major implication of the second view—the rapid onset of effects, frequent administration, reliability of action, and ease of availability with cigarette vehicles increase the dependence potential of nicotine—is that a regulatory system should acknowledge that a gradual phasing towards vehicles that deliver nicotine less rapidly, that require only infrequent use, and are less easily obtainable could reduce nicotine dependence.¹⁸

The major implication of the third view—lack of intoxication makes nicotine more dependence producing—is that perhaps we need to educate the public that the central feature of drug dependence is impaired control over drug use, not intoxication.² This view is especially important to transmit to adolescents as many incorrectly believe that because nicotine is not intoxicating, it has less dependence potential.²⁷

The major implication of the fourth hypothesis—the long duration of withdrawal undermines quit attempts—is that perhaps those who state withdrawal dissipates within one week need to, instead, state withdrawal does decline but often lasts a month or longer. Accordingly, we need to help smokers to plan their lives to accommodate the possibility that they will not be at their best for several weeks. In addition, we need to inform smokers that even if they are still having problems three weeks post-abstinence, this is likely to be withdrawal and they should be feeling better in the near future. Finally, we need to use this information to encourage quitters to remain on medications or in psychosocial treatments for longer than just a week or two.

Supported by Research Career Development Award 00109 and Senior Scientist Award 00490 from the National Institute on Drug Abuse.

- 1 US Department of Health and Human Services. *The health consequences of smoking: nicotine addiction. A report of the Surgeon General, 1988*. Rockville, Maryland: Public Health Service, Centers for Disease Control, Office on Smoking and Health, 1988. (DHHS Publication No (CDC) 88-8406.)
- 2 American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*, fourth edition. Washington: American Psychiatric Association, 1994.
- 3 Shadel WG, Shiffman S, Niaura R, et al. Current models of nicotine dependence: what is known and what is needed to advance understanding of tobacco etiology among youth. *Drug Alcohol Depend* 2000;59:S59-62.
- 4 Shoab M. Is dopamine important in nicotine dependence? *J Physiol* 1998;92:229-33.
- 5 Picciotto MR. Common aspects of the action of nicotine and other drugs of abuse. *Drug Alcohol Depend* 1998; 51:165-72.
- 6 US Department of Health and Human Services. *Preventing tobacco use among young people. A report of the Surgeon General, 1994*. Atlanta, Georgia: Public Health Service, Centers for Disease Control and Prevention, Office on Smoking and Health, 1994. (US Government Printing Office Publication No S/N 017-001-00491-0.)
- 7 Colby SM, Tiffany ST, Shiffman S, et al. Are adolescent smokers dependent on nicotine? A review of the evidence. *Drug Alcohol Depend* 2000;59:S23-40.
- 8 Warburton DM, Revell A, Walters AC. Nicotine as a resource. In: Rand MJ, Thureau K, eds. *The pharmacology of nicotine*. London: ICSU Press, 1988:359-73.
- 9 US Dept Health and Human Services. Effects of nicotine that may promote tobacco use. In: Benowitz NL, Grunberg NE, Henningfield JE, Lando HA, eds. *The health consequences of smoking: nicotine addiction. A report of the Surgeon General, 1988*. Rockville, Maryland: Public Health Service, Centers for Disease Control, Office on Smoking and Health, 1988 (DHHS Publication No (CDC) 88-8406.):377-458.
- 10 Hughes JR. Distinguishing withdrawal relief and direct effects of smoking. *Psychopharmacology* 1991;104:409-10.
- 11 Heishman SJ. What aspects of human performance are truly enhanced by nicotine? *Addiction* 1998;93:317-20.
- 12 Parrott AC, Garnham NJ. Comparative mood states and cognitive skills of cigarette smokers, deprived smokers and nonsmokers. *Hum Psychopharmacol* 1998;13:367-76.
- 13 Pomerleau CS, Pomerleau OF. Euphoriant effects of nicotine in smokers. *Psychopharmacology* 1992;108:460-5.
- 14 Shiffman S. Assessing smoking patterns and motives. *J Consult Clin Psychol* 1993;61:732-42.
- 15 Breslau N, Kilbey MM, Andreski P. DSM-III-R nicotine dependence in young adults: prevalence, correlates and associated psychiatric disorders. *Addiction* 1994;89:743-54.
- 16 Perkins KA, Stitzer M. Behavioral pharmacology of nicotine. In: Tarter R, Ammerman RT, Otte P, eds. *Handbook of substance abuse: neurobehavioral pharmacology*. New York: Plenum Press, 1998:299-317.
- 17 Skinner BF. *Contingencies of reinforcement: a theoretical analysis*. New York: Appleton, 1969.
- 18 Slade J, Henningfield JE. Tobacco product regulation: context and issues. In: Ogden JK, ed. *Food and Drug Law Journal Supplement*. Washington, DC: The Food and Drug Law Institute, 1998:44-74.
- 19 Robinson JH, Pritchard WS. The role of nicotine in tobacco use. *Psychopharmacology* 1992;108:397-407.
- 20 Mello NK, Mendelson JH. Experimentally induced intoxication in alcoholics: a comparison between programmed and spontaneous drinking. *J Pharmacol Exp Ther* 1970; 173:101-16.
- 21 Anthony JC, Warner LA, Kessler RC. Comparative epidemiology of dependence on tobacco, alcohol, controlled substances, and inhalants: basic findings from the national comorbidity survey. *Exp Clin Psychopharmacol* 1994;2:244-68.
- 22 Kandel D, Chen K, Warner LA, et al. Prevalence and demographic correlates of symptoms of last year dependence on alcohol, nicotine, marijuana and cocaine in the US population. *Drug Alcohol Depend* 1997;44:11-29.
- 23 Hughes JR, Higgins ST, Hatsukami DK. Effects of abstinence from tobacco: a critical review. In: Kozlowski LT, Annis H, Cappell HD, et al, eds. *Research advances in alcohol and drug problems*, vol 10. New York: Plenum Press, 1990:317-98.
- 24 Hughes JR. Tobacco withdrawal in self-quitters. *J Consult Clin Psychol* 1992;60:689-97.
- 25 Patten CA, Martin JE. Does nicotine withdrawal affect smoking cessation? Clinical and theoretical issues. *Ann Behav Med* 1996;18:190-200.
- 26 Piasecki TM, Fiore MC, Baker TB. Profiles in discouragement: two studies of variability in the time course of smoking withdrawal symptoms. *J Abnorm Psychol* 1998; 107:238-51.
- 27 Brecher EM. Nicotine as an addicting drug. *Licit and illicit drugs*. Boston: Little, Brown and Company, 1972:220-8.