HHS Public Access

Author manuscript

Prev Med. Author manuscript; available in PMC 2017 November 01.

Published in final edited form as:

Prev Med. 2016 November ; 92: 31–35. doi:10.1016/j.ypmed.2016.05.015.

A Behavioral Economic Perspective on Smoking Persistence in Serious Mental Illness

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Abstract

Serious mental illness (SMI) is associated with disproportionately high rates of cigarette smoking. The identification of factors that contribute to persistent smoking in people with SMI may lead to the development and adoption of tobacco control policies and treatment approaches that help these smokers quit. This commentary examines factors underlying smoking persistence in people with SMI from the perspective of behavioral economics, a discipline that applies economic principles to understanding drug abuse and dependence. Studies, conducted in the Northeastern US within the past 30 years, that compare the reinforcing effects of nicotine and the costs of smoking in smokers with and without schizophrenia and depression are discussed, and interventions that may reduce the reinforcing efficacy of nicotine and increase the costs of smoking in people with SMI are described.

Keywords

Schizophrenia; Depression; Comorbidity; Cigarette smoking; Tobacco dependence; Tobacco control; Socioeconomic status; Behavioral economics

People with serious mental illness (SMI) are 2–3 times more likely to smoke cigarettes, and smoke more cigarettes per day than those without mental illness (Lasser et al., 2000; McClave et al., 2010). Thus, people with current SMI, who make up approximately 28% of the US population, smoke approximately 44% of cigarettes sold in the US (Lasser et al., 2000). Approximately 50% of deaths in people with SMI are thought to be due to tobacco (Callaghan et al., 2014, Kelly et al., 2011). Pharmacological and behavioral treatments increase cessation among people with SMI (Evins et al., 2015), but, overall, their cessation rates are extremely low (Cook et al., 2014).

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Conflict of Interest

The author reports no conflicts of interest.

Numerous biological and environmental risk factors contribute to smoking among people with SMI, including poverty, unemployment, lack of clinical attention to tobacco use, deficits in working memory and task persistence, a paucity of, or insensitivity to, alternative reinforcers, and high levels of negative affect and low levels of positive affect (anhedonia), along with expectancies that smoking will improve these states (Tidey & Miller, 2015; Ziedonis et al., 2008). These factors can be considered through the lens of behavioral economics, a discipline that applies economic principles when examining why individuals engage in maladaptive behaviors (Bickel et al., 2014). According to this perspective, drug use is a function of both its reinforcing efficacy and its cost, in terms of monetary price, effort, or a relinquished opportunity to obtain an alternative reinforcer. Those who persistently use a drug are thought to overvalue its reinforcing effects and undervalue its costs, due to endogenous factors, such as a pathological reinforcement system, and exogenous factors, such as environmental deprivation. A behavioral economics perspective is conceptually sophisticated because it describes how persistent smoking results from interactions among these endogenous and exogenous costs and benefits, and is useful because it suggests novel approaches for reducing smoking in people with SMI. This commentary discusses results from experimental studies that have compared sensitivities to cigarette reinforcement and cigarette cost factors in smokers with and without SMI from a behavioral economics perspective. It focuses on smokers with schizophrenia (SS) and smokers with depression (SD), because the majority of experimental research on smoking in SMI has examined these populations.

Overvaluation of Cigarette Reinforcement among People with SMI

The prevalence of heavy smoking among SS and SD is higher than that of non-psychiatric smokers (de Leon & Diaz, 2005; Pratt & Brody, 2010). Furthermore, even after controlling for daily smoking rate, SS have higher levels of nicotine intake than non-psychiatric smokers, due to their intense smoking topography characteristics (Tidey et al., 2005; Williams et al., 2011). The functional significance of their elevated nicotine intake is unknown, but is often interpreted as reflecting attempts by SS to stimulate low-affinity alpha-7 nicotinic acetylcholine receptors (nAChRs) to remediate aberrant sensory gating and related cognitive deficits (Brunzell & McIntosh 2012). While this hypothesis is intuitively appealing, the evidence that SS experience stronger pro-cognitive effects of nicotine than other smokers is mixed (Hahn et al., 2013).

An alternative hypothesis is that the neuropathology underlying schizophrenia and depression confers heightened vulnerability to the reinforcing effects of nicotine (Brody et al., 2009; Chambers et al., 2001). This hypothesis is supported by preclinical research (Berg et al., 2014), but has been understudied in humans. One relevant study found that SS and SD made twice as many hypothetical choices for smoking versus alternative reinforcers (candy, seeing a movie) than the controls, suggesting that SS and SD experience stronger smoking reinforcement (Spring et al., 2003). Also consistent with this hypothesis is a study that found that after 3 days of continuous abstinence, SS reported stronger cigarette craving, a stronger smoking-related increase in positive mood, a stronger nicotine preference, and a greater hedonic response to nicotine than controls (Tidey et al., 2014; Figure 1). Likewise, SD made more responses for cigarette puffs vs. a monetary reinforcer and experienced a larger

increase in positive affect after smoking than controls (Audrain-McGovern et al., 2014). Finally, results from a study that used the Cigarette Purchase Task to compare SS and controls on hypothetical cigarette demand as a function of price are consistent with this hypothesis (MacKillop & Tidey, 2011). On this task, participants are asked to report the number of cigarettes that they would consume in one day at various costs. From these values, a demand curve can be constructed that relates price to consumption, and several demand indices can be generated: (a) demand intensity, which is consumption when the price is zero, (b) Omax, which is the maximum amount of money allocated to cigarettes, (c) breakpoint, which is the first price at which participant reports zero consumption, (d) Pmax, which is the price at which Omax occurs, and (e) α, which is the rate of decrease in consumption as a function of price (Hursh et al., 1988). This study found that SS reported a greater demand intensity, which was associated with higher *ad libitum* smoking rate, consistent with the idea that the incentive value of smoking is stronger among SS (MacKillop & Tidey, 2011).

In addition to its primary reinforcing effects, nicotine enhances the reinforcing effects of other stimuli, and these effects may be even more critical to maintaining nicotine self-administration than its primary reinforcing effects (Chaudri et al., 2006; Donny et al. 2003). This raises the question of whether stronger reinforcement-enhancing effects of nicotine in smokers with SMI compared to controls may contribute to smoking persistence in SMI. This hypothesis was recently supported by a study that found that SD, but not controls, reported greater enjoyment of activities in their natural environments while smoking than while abstinent (Audrain-McGovern et al., 2014). Among SS, this hypothesis was recently tested using a preclinical model of schizophrenia that examined whether pretreating rats with phencyclidine, to model the negative symptoms of schizophrenia, altered their responding for a visual stimulus paired with nicotine (Swalve et al., 2015). Although the results of this study were mixed, the hypothesis that SS experience stronger reinforcement-enhancing effects of nicotine than those without SMI merits investigation in human experimental studies.

Undervaluation of Smoking Costs among People with SMI

The costs of smoking include the price of cigarettes, the effort required to obtain them, the health consequences of smoking, and the opportunity cost incurred by forgoing an alternative reinforcer in order to smoke (Bickel et al., 2014). From a behavioral economic perspective, individuals who are less sensitive to these costs are more likely to smoke. Although few experimental studies have directly compared sensitivities to the monetary and behavioral costs of smoking in smokers with vs. without SMI, one study examined sensitivity to these costs in SS (Tidey et al., 1999) using the same experimental procedure and equipment as a study that had compared them in heavy smokers without psychiatric illness (Bickel et al., 1995). The effect of response cost on cigarette puff consumption was similar in these groups (Figure 2). A study that used a similar procedure to compare responses for cigarette puffs versus money in SD and controls across a range of response costs found that SD made twice as many responses for puffs than controls, but were not differentially sensitive to increases in response cost (Audrain-McGovern et al., 2014). Finally, a study that compared changes in cigarette demand as a function of price in SS and

controls found that the groups were equally sensitive to price increases (MacKillop & Tidey, 2011). Based on this limited evidence, SS and SD do not appear to be less sensitive to the monetary and behavioral costs of smoking than controls.

The most significant costs of smoking are its effects on health. SS, SD and controls matched on smoking rate report comparable levels of concern about the health costs of smoking (Tidey & Rohsenow, 2009; Weinberger et al., 2011). Furthermore, among both SS and controls, level of concern about the current and future negative health consequences of smoking is related to intention to quit within 6 months (Tidey & Rohsenow, 2009); however, whether level of health concern predicts cessation outcomes is unknown.

One cost factor on which smokers with and without SMI do differ is access and sensitivity to alternative reinforcers, and this may be an important link in the association between SMI and smoking. For example, depression is associated with a decrease in the frequency and pleasantness of non-smoking-related reinforcers, and this decrease is associated with smoking escalation in young adulthood (Audrain-McGovern et al., 2011). One mechanism underlying this association appears to be anhedonia, defined as diminished anticipation and enjoyment of events that are normally considered pleasurable. The association between anhedonia and smoking has been found in both experimental and longitudinal studies (Audrain-McGovern et al., 2012; Leventhal et al., 2014). Frequently associated with depression, anhedonia is also a common symptom of schizophrenia (Watson & Naragon-Gainey, 2010). The role of anhedonia in the association between schizophrenia and smoking is understudied, but one recent study found that anhedonia was associated with cigarette craving in SS, and a related behavioral measure, reward-based learning, was associated with nicotine dependence severity (AhnAllen et al., 2012). Anhedonia may also partly account for the finding that alternative reinforcers competed relatively poorly for smoking reinforcement among SS and SD (Spring et al., 2003).

Behavioral Economic Approaches to Reducing Smoking in SMI

From a behavioral economic perspective, smoking cessation rates among people with SMI can be increased by reducing the reinforcing efficacy of cigarettes and increasing the costs of smoking. The reinforcing efficacy of cigarettes can be reduced by lowering their nicotine content below an addiction threshold (Benowitz & Henningfield, 2013). Among a general population sample of smokers, use of very low nicotine content (VLNC) cigarettes decreases smoking and cigarette demand, and increases sensitivity to cigarette cost (Donny et al., 2015; Smith et al., 2015). This suggests that an FDA-mandated reduction in the nicotine content of cigarettes, as authorized by the 2009 Tobacco Control Act, may increase the effectiveness of other tobacco control approaches and smoking cessation treatments. Among SS, acute VLNC cigarette use reduces cigarette craving, withdrawal, and smoking (Tidey et al., 2013), and studies of extended VLNC cigarette use in SS and SD are underway (https://clinicaltrials.gov/ct2/show/NCT02019459, https://clinicaltrials.gov/ct2/show/NCT01928758, https://clinicaltrials.gov/ct2/show/NCT02232737). Another method of reducing the reinforcing efficacy of cigarettes is varenicline treatment. As a low-efficacy agonist at alpha4beta2 nAChRs, varenicline both partially substitutes for and blocks the full agonist effects of nicotine (Mihalak et al., 2006), and recent studies have found it to be safe and

effective in SS and SD (Evins et al., 2015). Furthermore, varenicline also substitutes for and blocks the reinforcement-enhancing effects of nicotine (Levin et al., 2012).

Several potential methods of increasing the costs of smoking in SMI should be explored. Increasing cigarette excise taxes and reducing cigarette outlets in socioeconomically-deprived areas should help to reduce smoking persistence in SMI (Institute of Medicine, 2007), particularly if low-cost treatments are also made available to these smokers. Providing smokers with personalized risk profiles, such as their lung age or heart age (Morris & Temple, 1985; Davies et al., 2013), and training them to imagine positive future events (e.g., Daniel et al., 2013) may help motivate smokers with SMI to seek treatment by increasing the immediacy and salience of the health costs of smoking and the benefits of abstinence. Helping them to identify and engage in substitute reinforcing activities may reduce the likelihood of relapse during cessation treatment by increasing the opportunity cost of smoking (Goelz et al., 2014).

Finally, contingency management (CM) interventions directly increase the opportunity cost of smoking by delivering tangible incentives upon objective evidence of abstinence (Higgins et al., 2002). CM interventions are highly effective in people with SMI (Tidey, 2012). For example, among SS, a 3-week CM intervention decreased nicotine intake by 34%, compared to a 4% decrease among those randomized to the control condition (Tidey et al., 2011). Among depression-prone pregnant and post-partum women, CM reduced smoking and depression severity (Lopez et al., 2015). These promising findings warrant the development of longer CM smoking cessation interventions for people with SMI, including internet- and smart phone-based CM approaches (e.g., Dallery et al., 2013). Considering the high rates of smoking persistence among people with SMI, combined treatments that both reduce the reinforcing value of smoking and increase the cost of smoking are also warranted. For example, the effectiveness of CM interventions for smoking would likely be enhanced if combined with an approach that reduces the reinforcing efficacy of cigarettes, such as varenicline or VLNC cigarettes.

Conclusions

People with SMI are not benefiting from current tobacco control policies and treatments. From a behavioral economic perspective, improving their cessation rates will require changing the benefit-cost ratio of smoking. As reviewed in this commentary, policies and treatment approaches that can increase the costs and reduce the reinforcing efficacy of cigarettes in people with SMI include reducing the nicotine content of cigarettes to a minimally-addictive level, reducing cigarette availability, and facilitating access to varenicline and contingency management treatments. In addition, research is warranted to examine whether combinations of these approaches, such as varenicline combined with contingency management or very low nicotine content cigarettes, will help people with SMI achieve and maintain smoking abstinence.

Acknowledgments

This manuscript is based on symposium papers presented at the 2015 meetings of the College on Problems of Drug Dependence and the Vermont Center on Behavior and Health. I am grateful to Adam M. Leventhal, Ph.D., and

Stephen T. Higgins, Ph.D., for inviting me to participate in those symposia, and to Warren K. Bickel, Ph.D., whose insights spurred my interest in behavioral economics. The preparation of this manuscript was supported by grants P50DA036114 and U54DA031659 from National Institute on Drug Abuse and the Food and Drug Administration's Center for Tobacco Products.

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Highlights

- People with serious mental illness have very low smoking cessation rates.
- Reducing smoking requires decreasing cigarette reinforcement and increasing its cost.
- Very low nicotine cigarettes and varenicline increase reduce smoking reinforcement.
- Contingency management interventions increase the opportunity cost of smoking.
- Combining these interventions may have additive effects.

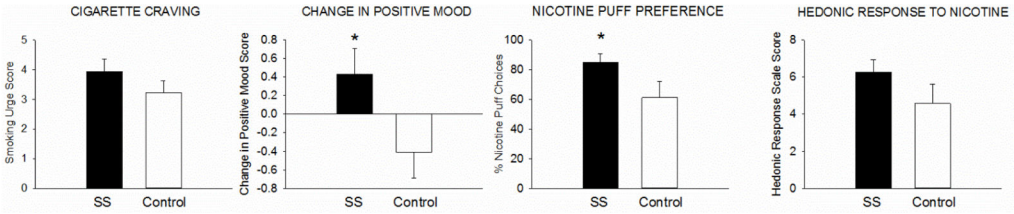

Figure 1.

Cigarette craving, smoking-related change in positive-mood, percent choices for nicotine puffs, and hedonic response to nicotine puffs, in smokers with schizophrenia (SS) and equally-heavy smokers without psychiatric illness. Bars represent Mean +/− SEM. * indicates a significant difference between groups ($p < .05$). Data were collected in Providence, RI, in 2009–2012. From Tidey et al., 2014.

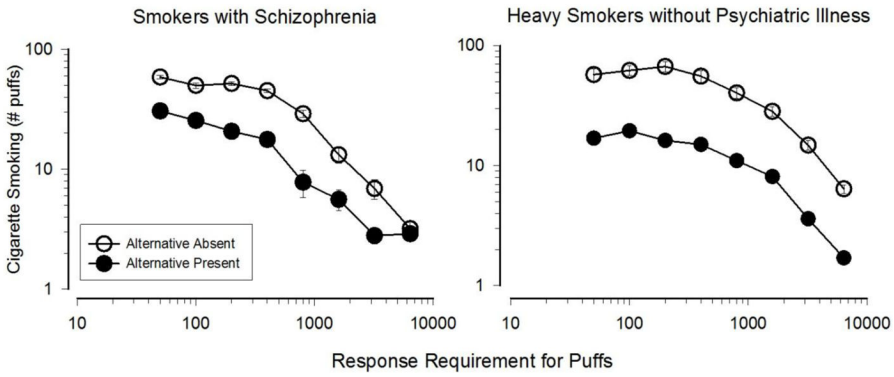

Figure 2.

Effects of varying the effort (response requirement) for cigarette puffs, and the presence or absence of an alternative monetary reinforcer, on smoking in smokers with schizophrenia (left; reprinted from Tidey et al., 1999) and smokers without psychiatric disoders (right; data from Bickel et al., 1995). Data were collected in the 1990s in Burlington. VT. Points represent Mean +/− SEM.