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Mood, mood regulation expectancies and frontal systems functioning in current smokers versus never-smokers in China and Australia

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HIGHLIGHTS

- In Australia and China smokers report worse moods than nonsmokers.
- In Australia and China smokers show worse executive function than nonsmokers.
- Chinese smokers scored worse than Australian smokers on all measures.
- Results fail to support the "hardening" hypothesis and suggest the opposite.
- Ease of smoking in China may promote nicotine dependence and "hardening".

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ABSTRACT

Indices of mood, mood regulation expectancies and everyday executive functioning were examined in adult current smokers and never-smokers of both genders in Australia ($N = 97$), where anti-smoking campaigns have dramatically reduced smoking prevalence and acceptability, and in China ($N = 222$), where smoking prevalence and public acceptance of smoking remain high. Dependent measures included the Depression Anxiety Stress Scales (DASS-21), the Negative Mood Regulation (NMR) expectancies scale, the Frontal Systems Behavior Scale (FrSBe), the Fagerström Test for Nicotine Dependence (FTND) and the Alcohol Use Disorders Identification Test (AUDIT). Multivariate analyses of covariance (MANCOVAs) controlling for demographic and recruitment related variables revealed highly significant differences between current smokers and never-smokers in both countries such that smokers indicated worse moods and poorer functioning than never-smokers on all dependent measures. Chinese smokers scored significantly worse on all dependent measures than Australian smokers whereas Chinese and Australian never-smokers did not differ on any of the same measures. Although nicotine dependence level as measured by FTND was significantly higher in Chinese than Australian smokers and was significantly correlated with all other dependent measures, inclusion of FTND scores as another covariate in MANCOVA did not eliminate the highly significant differences between Chinese and Australian smokers. Results are interpreted in light of the relative ease of taking up and continuing smoking in China compared to Australia today.

1. Introduction

Tobacco smoking remains the leading preventable cause of death worldwide. Of approximately one billion current smokers, about 500 million will eventually die from a smoking related illness (World Health Organisation [WHO], 2011). Smoking prevalence varies considerably across countries, with "Anglo" countries such as the United States, Canada and Australia reporting much lower rates of smoking in recent years than East Asian countries such as China, South Korea and Japan. For example, a 2010 survey (Li, Hsia, & Yang, 2011) reported that 46% of adult men in China were current daily smokers, whereas a 2010 survey in Australia (Australian Institute of Health and Welfare [AIHW], 2011) reported that only 14% of adult men were current daily smokers. This large difference in smoking prevalence rates, at least for men (prevalence rates are considerably lower among women in both countries but especially in China), reflect very different community attitudes towards smoking in China versus Australia.

"Anglo" countries such as Australia, Canada and the United States have made considerable efforts to decrease cigarette smoking, resulting in a steady decrease in smoking prevalence over the past several decades (AIHW, 2011; Morrell & Cohen, 2006) except perhaps among the population of those suffering from frequent depression, stress or emotional problems (New York State Department of Health, 2012). In Australia, heavy taxation of tobacco products, smoke-free environment legislation, bans on tobacco advertising, and gruesome ads depicting

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horrific health consequences of smoking are some of the approaches taken by anti-smoking campaigns. There has been no comparable effort to date in China, which remains the largest consumer of tobacco products in the world, has one third of the world's smokers and produces nearly half of all cigarettes worldwide (Li et al., 2011; Peto, Zheng-Meng, & Boreham, 2009). Although China is a signatory to the World Health Organization Framework Convention on Tobacco Control, and smoking cessation programs are available in some areas, smoking rates in China appear to be stable or even rising (Hughes, 2012), and public awareness of the adverse health effects of smoking is minimal (Peto et al., 2009).

In Australia approximately 40% of smokers attempt to quit each year (Cooper, Borland, & Yong, 2011), though only half of those who attempt to quit are reportedly successful at maintaining abstinence from smoking for a one-month period (AIHW, 2008). Negative affect appears to impact quit attempts, with smokers who report high levels of negative affect tending to be less successful at quitting (Anda et al., 1999; Kassel, Stroud, & Paronis, 2003; Shiffman et al., 1997; Spielberger, Foreyt, Reheiser, & Poston, 1998). Many research investigations have found strong associations between smoking and negative affective states such as depression, anxiety and stress (e.g., Fergusson, Goodwin, & Horwood, 2003; Kassel et al., 2003; Lyvers, Thorberg, Dobie, Huang, & Reginald, 2008; McChargue, Cohen, & Cook, 2004a,b; New York State Department of Health, 2012; Patton et al., 1998, 1996; Pedersen & von Soest, 2009). For example, Patton et al. (1996) found that even after controlling for academic level, gender, alcohol consumption and parental smoking, adolescents reporting high levels of anxiety and depressive symptoms were approximately twice as likely to smoke compared to those reporting low levels of such symptoms.

More recent data from two large Australian national household surveys found that current smokers reported higher levels of psychological distress than their ex-smoker and non-smoker peers, particularly if the current smokers smoked a high number of cigarettes per day and had attempted to quit but failed (Leung, Gartner, Dobson, Lucke, & Hall, 2011). Mykletun, Overland, Aarø, Liabø, and Stewart (2008) examined the association between depression, anxiety and smoking in participants aged 20 to 89 years from a population-based health survey in Norway ($N = 60{,}814$); smoking levels were highest in participants with co-morbid anxiety and depression, followed by anxiety and then depression. Anxiety and depression were more prevalent in current smokers than in ex-smokers or in people who had never smoked. Behavioral signs of frontal lobe dysfunction have also been associated with smoking. Spinella (2003) found that current smokers reported more signs of frontal lobe dysfunction than non-smokers on all three subscales of the Frontal Systems Behavior Scale (FrSBe; Grace & Malloy, 2001). Deficits of frontal lobe functioning as well as structural deficiencies in prefrontal regions are well known in other addictions including alcoholism, cocaine addiction and heroin addiction (Lyvers, 2000). Like those other forms of drug addiction, brain imaging signs of less prefrontal gray matter and smaller prefrontal volume have been observed in heavy smokers compared to nonsmokers (Brody et al., 2004; Zhang et al., 2011).

Shared genetic influences may account for part of the link between smoking and depression (Dierker, Avenevolli, Stolar, & Merikangas, 2002), however even when controlling for genetic influences the association of smoking with depression persists (Korhonen et al., 2007). Both directions of causation may underlie the relationships between smoking and indices of negative affect or cognitive deficit. Depression and anxiety appear to increase the risk of initiating smoking (Escobedo, Reddy, & Giovino, 1998; Patton et al., 1998; Polen et al., 2004), suggesting that those suffering from frequent negative moods are more likely to take up and continue smoking as a form of self-medication (Dinn, Aycicegi, & Harris, 2004; Warburton, 1992). Nicotine can have anxiolytic and antidepressant effects and thus may be used by smokers to alleviate negative moods (Morissette, Tull, Gulliver, Kamholz, & Zimering, 2007). Adan, Prat, and Sanchez-Turet (2004) found that while both light and heavy smokers reported more negative affect than non-smokers, the heavy smoker group reported worse pre-cigarette and post-cigarette moods than the light smokers did. Behavioral traits related to poor executive function such as impulsivity, risk-taking and disinhibition have also been reported to increase the likelihood of smoking (Carton, Jouvent, & Widlocher, 1994; Dinn et al., 2004; Lejuez, Aklin, Bornovalova, & Moolchan, 2005; Spillane, Smith, & Kahler, 2010), with longitudinal research indicating that risk-taking in childhood predicted adult smoking (Burt, Dinh, Peterson, & Sarason, 2000). Perhaps those who are inclined to take risks and/or who have short time horizons are less likely to be influenced by public health campaigns concerning the long-term adverse consequences of smoking. In any case the notion that those who suffer from frequent negative mood states and/or who exhibit traits linked to poor executive function are more likely to take up and continue smoking has ample support from research findings.

On the other hand, evidence also indicates that chronic smoking may itself worsen mood and cognitive functioning. Shahab and West (2012) examined self-reported happiness in current smokers, ex-smokers and never-smokers in a large U.K. sample ($N = 6923$). Ex-smokers who had quit for more than a year reported similar levels of happiness to never-smokers, levels which were significantly higher than in current smokers; ex-smokers who had quit for less than a year reported similar levels of happiness as current smokers. The authors concluded that their findings strengthen the evidence for a causal relationship between smoking and negative affective states, with smoking cessation leading to improvements in mood. Consistent with this idea, longitudinal research indicates that taking up smoking increases the likelihood of experiencing depressive symptoms (Boden, Fergusson, & Horwood, 2010; Kang & Lee, 2010). Cognitive functioning may also be adversely affected by heavy smoking and associated nicotine dependence. Lyvers, Maltzman, and Miyata (1994) found that when chronic heavy smokers were deprived of nicotine for 12 h they performed significantly worse than non-smokers on a well-known neuropsychological test of frontal lobe related cognitive functioning, the Wisconsin Card Sorting Test (WCST); heavy smokers performed at the level of non-smokers only after smoking a cigarette. The findings were interpreted as reflecting an adverse effect of nicotine addiction on the functioning of the prefrontal cortex, a region heavily innervated by dopaminergic inputs from the ventral tegmental area where nicotine activates dopaminergic neurons (Mihailescu & Drucker-Colin, 2000). Similar performance deficits on the WCST were observed in opioid-addicted methadone maintenance patients who were acutely deprived of methadone compared to those who had been given their daily methadone dose (Lyvers & Yakimoff, 2003). However, the study by Lyvers et al. (1994) could not rule out the possibility that the smokers in their study had deficient executive function even before taking up smoking and that smoking had a cognitive enhancing effect that normalized their performance on the test. Likewise although Lyvers and Miyata (1993) observed a nicotine-reversible deficit in psychophysiological indices of attention during nicotine abstinence in heavy smokers, the possibility that an attention deficit may have predated onset of smoking could not be ruled out.

Parrott (2004, 2005, 2006) proposed that whereas the self-medication model of smoking maintenance is based on the assumption that mood (and perhaps attention and cognition) acutely improves as a result of smoking, as often reported by smokers themselves (Copeland, Brandon, & Quinn, 1995; Shiffman, 1993), nicotine dependence may cause frequent fluctuations in smokers' moods which could be the primary cause of their higher self-reported negative affect compared to nonsmokers. Parrott suggested that the degree of negative affect experienced by smokers is directly related to their level of nicotine dependence, an idea consistent with the view that drug addictions are characterized by "hedonic homeostatic dysregulation" reflecting alteration of anterior brain dopamine systems by frequent drug use (Koob & Le Moal, 1997). Thus anxiety and stress tend to decrease after quitting smoking even after controlling for stressful life events (Carey, Kalra, Carey, Halperin, & Richards, 1993; Chassin, Presson, Sherman, & Kim, 2002; Cohen & Lichtenstein, 1990; Parrott, 2005;