



Smoking, arousal, and affect: The role of anxiety sensitivity

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ABSTRACT

Purpose: Despite evidence that smoking elevates peripheral autonomic nervous system activity, cigarette smokers commonly report smoking to reduce negative affect, or “calm down.” Studies suggest that anxiety sensitivity is positively associated with the use of anxiolytic substances, but anxiety sensitivity is also characterized by aversive responding to elevations in physiological arousal. As such, anxiety sensitivity may be an important factor in the study of smoking, affect, and arousal.

Method: Smokers smoked cigarettes in two experimental sessions: a Stressful Speech Condition and a No Stress Condition. Psychophysiological and self-report served as within-subjects, repeated measures.

Results: Findings revealed that smoking reduced anxiety in high anxiety sensitive smokers who smoked during a stressful situation, but not a no stress situation. Low anxiety sensitive smokers endorsed anxiolysis in both conditions.

Conclusions: Results suggest that high anxiety sensitive smokers may be sensitive to the physiologically arousing effects of smoking in low stress, low arousal, situations.

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1. Introduction

According to recent estimates (Centers for Disease Control and Prevention, 2006), approximately 23% of the U.S. population smokes tobacco, a particularly disconcerting revelation considering that the 1964 Surgeon General’s Report on the deleterious health consequences of smoking was published more than 40 years ago. Therefore, research investigating the factors that govern initiation, maintenance, and cessation of smoking behavior is vital to public health efforts. The relationship between smoking and affect is one area of study that may help further illuminate some of these factors.

Popular opinion holds that, like many other psychoactive drugs, nicotine may be used, at least in part, to regulate emotion. Indeed, a common expectation of both adult (Copeland, Brandon, & Quinn, 1995) and adolescent (Lewis-Esquerre, Rodrigue, & Kahler, 2005) smokers is that smoking somehow alleviates negative affect. Yet, studies examining the direct effects of smoking on negative affect have provided mixed results. As such, researchers have investigated factors that may mediate or moderate these relationships (Kassel, Stroud, & Paronis, 2003).

The physiologically arousing effects of cigarette smoking appear to be at odds with smoking’s supposed calming effects. Studies have found that smoking reliably increases heart rate (HR)

(Byrne, 2000; Gilbert, Meliska, Welsler, & Estes, 1994; Masson & Gilbert, 1999), blood pressure (Dembroski, MacDougall, Cardoza, Ireland, & Krug-Fite, 1985; MacDougall, Dembroski, Slaats, Herd, & Eliot, 1983; Perkins, Epstein, Jennings, & Stiller, 1986), serum cortisol concentration (Gilbert, Dibb, Plath, & Hiyane, 2000; Gilbert et al., 1994; Pomerleau & Pomerleau, 1990) and skin conductance (SC) (Byrne, 2000; Perkins, Grobe, Fonte, & Breus, 1992). These physiological indices are believed to be associated with states of stress and anxiety. It is therefore perplexing that smoking would lessen negative affect, especially anxiety, while concurrently elevating physiological arousal. Nesbitt (1973) identified this seemingly paradoxical relationship between smoking’s stimulating effects on peripheral autonomic nervous system arousal and anxiolytic effects on self-reported anxiety, with this phenomenon subsequently being coined “Nesbitt’s Paradox.”

1.1. Nesbitt’s Paradox

An essential factor to consider in investigating Nesbitt’s Paradox is whether smoking reliably elevates physiological arousal while decreasing anxiety. With respect to the effects of smoking on subjective anxiety, studies have yielded mixed results. Whereas several investigations have found that smoking reduced subjective stress or anxiety (Gilbert, Robinson, Chamberlin, & Spielberger, 1989; Jarvik, Caskey, Rose, Herskovic, & Sadeghpour, 1989; Pomerleau & Pomerleau, 1987; Woodson, Buzzi, Nil, & Baettig, 1986), others have observed no significant change in anxiety at all (Hatch, Bierner, & Fisher, 1983; Herbert, Foulds, & Fife-Schaw, 2001).

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Recent studies have attempted to reconcile equivocal findings by investigating the conditions under which smoking may decrease anxiety. For instance, one investigation (Juliano & Brandon, 2002) found that whereas smoking reduced negative affect, this effect was most pronounced when the participant held expectancies that it would do so. Findings from a later study (Wetter et al., 2004) revealed that the expectancy that smoking would reduce negative affect was a significant predictor of smoking status at a 4-year follow-up among occasional smokers. In support of the *attentional mediational model* (Kassel, 1997), findings indicate that smoking can alleviate anxiety, but only when combined with benign distraction (Kassel & Shiffman, 1997; Kassel & Unrod, 2000). These results are consistent with Gilbert and Gilbert's (1998) Situation X Trait Adaptive Response (STAR) Model, which postulates that the emotion-modulating effects of smoking are dependent on both individual differences and the situation in which someone smokes (Gilbert, 1995).

In sum, current findings indicate that whereas smoking may alleviate anxiety, this effect depends on individual differences (e.g., trait anxiety; Kassel & Unrod, 2000) and situational context. However, even after considering the contexts under which smoking affords anxiety reduction, it is still unclear why smoking would alleviate anxiety while concurrently increasing physiological indices of arousal, such as HR, blood pressure, and SC (responses that are traditionally associated with the stress response). One study found that, whereas, smoking elevated HR, smokers did not report perceiving these differences after smoking (Gilbert & Hagen, 1980). This finding suggests that there may not be a paradox per se, as smokers are not subjectively aware of smoking's effects on physiological arousal. On the other hand, recent evidence suggests that certain individual difference variables may account for how well someone perceives changes in physiological arousal (Ehlers, 1993). As such, some smokers may be aware of elevations in physiology due to smoking, while others may not. In addition, not all smokers might perceive such elevations as aversive.

1.2. Anxiety sensitivity and substance use

Anxiety sensitivity (AS) is a construct tapping the extent to which someone believes a physiologically arousing stimulus will lead to imminent personal harm or threat (Reiss, Peterson, Gursky, & McNally, 1986). One potential misconception regarding AS would be that it is positively associated with increased physiological reactivity to arousing stimuli. In fact, evidence suggests that only the *perception* of arousal differs between high and low anxiety sensitive individuals (Stewart, Buffett-Jerrott, & Kokaram, 2001; Zvolensky, Eifert, & Lejuez, 2001). Research suggests that high anxiety sensitive individuals are more sensitive to changes in sympathetic nervous system arousal (Richards & Bertram, 2000) and may be able to more accurately estimate bodily sensations, such as HR, relative to low anxiety sensitive individuals (Ehlers & Breuer, 1992; Stewart et al., 2001; Sturges & Goetsch, 1996). Ehlers (1993) hypothesized that such enhanced ability to accurately estimate changes in physiological activity (interoception) is responsible for aversive responding to arousal inducing stimuli in high anxiety sensitive individuals.

Whereas the largest body of research investigating AS has focused on the relationship between AS and various anxiety disorders (see Taylor, Koch, & McNally, 1992; Schmidt, Lerew, & Jackson, 1997), research investigating the role of AS in substance use has garnered increasing attention. Studies indicate that AS is positively associated with drug use frequency, even after controlling for anxiety and mood disorder diagnosis (DeHaas, Calamari, & Bair, 2002). Moreover, AS is positively correlated with alcohol consumption in both university woman (Stewart, Peterson, & Pihl,

1995) and panic disordered patients (Cox, Swinson, Shulman, & Kuch, 1993). Studies suggest that high anxiety sensitive individuals are more likely to drink primarily for coping reasons, that is, they drink to reduce negative affect (Stewart & Zeitlin, 1995; DeHaas, Calamari, Bair, & Martin, 2001).

Recent research indicates that the relationship between AS and substance use attributable to affect regulation is stronger in substances that depress physiological activity (DeHaas, Calamari, & Bair, 2002). Moreover, high AS individuals are more likely to use alcohol and other depressant drugs when experiencing negative affect (DeHaas, Calamari, Bair, & Martin, 2001). These findings are consistent with McNally's (1996, 1999) hypothesis that high anxiety sensitive individuals are prone to use substances that decrease arousal more frequently relative to substances that increase arousal.

Whereas cigarettes are known to stimulate indices of physiological arousal, it follows that AS would be associated with decreased use of cigarettes. Contrary to this notion, studies have not revealed a relationship between AS and smoking frequency (Novak, Burgess, Clark, Zvolensky, & Brown, 2003; Zvolensky, Kotov, Antipova, & Schmidt, 2003) or status (Zvolensky, Kotov, Bonn-Miller, Schmidt, & Antipova, 2008). In fact, studies have shown that AS is actually positively related to smoking to cope with negative affect (Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001; Comeau, Stewart, & Loba, 2001). Several studies have also found that AS poses an increased risk of smoking relapse (Brown et al., 2001; Zvolensky, Bonn-Miller, Bernstein, & Marshall, 2006). One recent investigation found that AS predicted early smoking lapse, but not early smoking relapse (Zvolensky, Stewart, Vujanovic, Gavric, & Steeves, 2009). In sum, findings suggest that AS is not related to decreased smoking rates and is in fact associated with smoking to cope with negative affect as well as poor smoking cessation outcomes.

1.3. Anxiety sensitivity, stress, and anxiolysis

Past research suggests that the physiologically arousing effects of nicotine and perceived stress are additive (Byrne, 2000; Davis & Matthews, 1990; Dembroski et al., 1985; MacDougall et al., 1983; Perkins et al., 1986, 1992; Pomerleau & Pomerleau, 1990). Therefore, if high AS individuals are, indeed, more accurate at perceiving increases in physiological arousal, it follows that they may react aversively to the combined effects of cigarette smoking and stressful situations. On the other hand, low AS individuals may not be aware of, or bothered by, these changes at all. This hypothesis rests on the assumption that the combined physiologically arousing effects of smoking and stress can compete with the anxiolytic benefits derived from smoking. Consistent with this notion, a burgeoning literature suggests that different neural structures may be involved in unique aspects of positive and negative affective responses (see Cacioppo & Gardner, 1999; Sutton & Davidson, 1997). Moreover, Damasio's (1993) Somatic Marker Hypothesis specifically hypothesizes that the feeling of an emotion necessitates the continuous monitoring of the juxtaposition of both the body state (peripheral autonomic arousal, motor, endocrine, and peptide systems) and representational mental state accompanying an emotional experience. Recent investigations of the right interior insula, a brain area associated with mental representations of body states (interoception), indicate that elevations in arousal associated with activity in the right interior insula are accompanied by negative emotional responses (Critchley, Mathias, & Dolan, 2002; Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004). Together, these data suggest that different neural substrates are involved in positive and negative emotional responses, while interoceptive representations of body states tend to be associated with negative emotional responses.

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