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A Comparison of Daily and Occasional Smokers' Implicit Affective Responses to Smoking Cues

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Highlights

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► Affective Misattribution Procedure was used to assess responses to smoking cues. ► Daily smokers responded more positively to active smoking cues than control cues. ► Occasional smokers showed no difference in their implicit responses to the cues. ► Responses to active cues were significantly related to cognitive enhancement only. ► Responses to inactive cues were related to cognitive enhancement and reinforcement.

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ABSTRACT

Previous research has not compared implicit affective responses to smoking-related stimuli in occasional (i.e., those who smoke less than one cigarette per day) and daily smokers (i.e., those who smoke at least once per day). In addition to assessing their motivations for smoking, implicit affective responses were measured using the Affect Misattribution Procedure (AMP) in occasional ($n = 19$) and daily smokers ($n = 34$) to smoking-related and neutral cues. Half of the cues depicted a human interacting with an object (i.e., active), whereas the remaining cues depicted objects alone (i.e., inactive). Results indicated that for the active cues, daily smokers responded more positively to smoking-related than to neutral cues, whereas occasional smokers showed no difference in their implicit responses. In addition to smoking frequency, relative differences in implicit responses to active cues were related to cognitive enhancement motivation. For inactive cues, implicit responses were related to cognitive enhancement as well as reinforcement. Because daily smokers have more positive implicit responses to active smoking-related cues than occasional smokers, these cues may play an important role in maintaining smoking behavior in daily smokers.

1. Introduction

Tobacco addictions are prevalent in our society and represent a serious risk to the health of smokers and those around them. According to the American Cancer Society (2009), smoking is currently the leading preventable cause of death within the United States, with over 440,000 deaths per year. Although most age groups in the United States have shown a decline in smoking behavior in the last few decades, current smoking prevalence has remained stable among those aged 18–24 years (Centers for Disease Control & Prevention (CDC), 2009). Although many individuals begin smoking in adolescence, a sizable proportion of individuals begin smoking or show increases in smoking behavior after age 18 (*e.g.*, Chassin, Presson, Pitts, & Sherman, 2000; Chassin, Presson, Sherman, & Edwards, 1991).

Although several studies have found that many college students explicitly report negative attitudes towards smoking regardless of their own smoking behavior (Elders, Perry, Eriksen, & Giovino, 1994; Goddard, 1992; Johnston, O'Malley, & Bachman, 1996; Stern, Prochaska, Velicer, & Elder, 1987), social desirability may diminish the reporting of positive emotions in self-reports of attitudes towards smoking (*e.g.*, Swanson, Rudman, & Greenwald, 2001). Because of the limitations of explicit measures, researchers use implicit measures to examine smokers' affective reactions to smoking by focusing on their responses to smoking-related cues, such as pictures of cigarettes or other smoking-related objects, using a range of paradigms such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). Although implicit affective responses to smoking-related cues provide important insights for understanding how environmental cues maintain smoking behavior, studies examining implicit responses to smoking cues have produced inconsistent results, with some experiments showing that smokers have positive implicit associations (*e.g.*, Sherman, Rose, Koch, Presson, & Chassin, 2003), and others showing that smokers have negative implicit associations with smoking cues (*e.g.*, Swanson et al., 2001).

One reason for inconsistencies in this research may be because these studies have not distinguished between smoking styles. This may be particularly important to consider for college-age smokers who demonstrate considerable individual variability in their smoking frequency (Colder et al., 2006). Of the more than 40% of college students who report that they smoke (Stromberg, Nichter, & Nichter, 2007), approximately 40–50% are daily smokers who smoke at least one cigarette every day and exhibit physiological and psychological withdrawal symptoms when deprived of cigarettes for a prolonged period of time; the remaining are occasional smokers (Moran, Wechsler, & Rigotti, 2004; Oksuz, Mutlu, & Malhan, 2007), who do not smoke every day and generally smoke in social situations (Leatherdale & McDonald, 2005; Stromberg et al., 2007). Differences between occasional and daily smokers have been shown in regards to their internal and external motivations for smoking. For example, daily smokers often report that their smoking behavior is motivated by internal cues such as negative ~~effect,~~ boredom, stress sensory satisfaction, and for appetite or weight control. In contrast, occasional

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smokers are motivated by environmental cues, which include social situations, such as interactions with peers who smoke (Otsuki, Tinsley, Chao, & Unger, 2008; Stromberg et al., 2007). Given these motivational differences, it seems wise to analyze these groups separately when investigating their affective responses to smoking-related cues (Fagerström, 1978; Tiffany & Drobes, 1990; Wetter et al., 2004). To our knowledge, there have been no studies that examine differences in implicit affective responses to smoking-related cues between occasional and daily smokers.

A second reason for the inconsistencies in college smokers' implicit affective responses to smoking-related cues may be the variation in the types of stimulus pictures employed in previous studies (Stritzke, Breiner, Curtin, & Lang, 2004). Many studies use pictures depicting humans interacting with drug-related objects as well as the objects alone (*e.g.*, Payne, Cheng, Govorun, & Stewart, 2005; Sherman et al., 2003). However, to our knowledge, none of these studies has investigated whether participants respond differently to these two types of stimuli. This could produce unwanted variability in participants' responses because psychophysiological evidence shows that stimuli containing people are processed differently from stimuli containing objects (*e.g.*, Haaga & Allison, 1994; Bentin, Allison, Puce, Perez, & McCarthy, 1996; Bobes, Valdés-Sosa, & Olivares, 1994; VanRullen & Thorpe, 2001). In fact, a recent study by Forestell et al. (2011) demonstrated that non-smoking college students with a history of family smoking attend differently to smoking-related pictures with human content compared to those with only smoking-related objects presented alone.

Finally, methodological issues that undermine the reliability and validity of implicit measures may have also produced inconsistencies in the literature. To address this concern, Payne et al. (2005) developed the Affect Misattribution Procedure (AMP) as an implicit measure of affective responses to cues. In this paradigm, participants are shown a prime picture followed by a Chinese pictograph and are asked to rate whether the pictograph is pleasant or unpleasant. Because the pictographs are ambiguous to participants and do not independently initiate emotional responses, participants' evaluation of the pictographs is implicitly related to their evaluation of the preceding prime. Discriminant validity has been shown to exist between various explicit measures, such as self-reported attitudes, and the AMP (Payne et al., 2005). Moreover, AMP responses to alcoholic ~~drinks~~ correlated with participants' reported weekly consumption of alcohol (Payne, Govorun, & Arbuckle, 2007). These psychometric properties suggest that the AMP may be an effective procedure for measuring implicit affective responses to drug-related cues.

In a recent study using the AMP procedure, Payne, McClernon, and Dobbins (2007) found that smokers' responses to smoking-related and non-smoking-related neutral pictures did not differ. These results are in contrast to previous findings in which smokers were placed in groups based on their smoking behavior, suggesting that affective responses to smoking-related pictures may vary as a function of smoking status. For example, Sherman et al. (2003~~)~~, Study 2) used the IAT to examine the implicit responses of college smokers and found that light smokers (i.e., less than 15 cigarettes a day) responded more negatively to smoking-related pictures than heavy smokers (i.e., more than 15 cigarettes a day), Thus, implicit reactions to smoking cues may vary as a function of smoking frequency. Because participants reported smoking 1–20 cigarettes per day in Payne, Govorun, and Arbuckle (2007); Payne, McClernon, and Dobbins (2007) ~~study~~, it is possible that the more positive emotional responses to smoking-related cues in heavy smokers was counteracted by lighter smokers' negative emotional responses to smoking-related cues. To address this issue, in the current study, we divided smokers into two groups based on their smoking frequency. That is, the affective reactions of daily smokers who report smoking every day and exhibit physiological and psychological withdrawal symptoms when deprived of cigarettes for a prolonged period of time were compared to those of occasional smokers (Moran et al., 2004; Oksuz et al., 2007).

The current study was designed to address three questions. First, implicit affective responses to smoking-related and non-smoking-related control cues were compared across occasional and daily smokers. Based on differences in implicit affective responses found between light and heavy ~~daily~~ smokers (Sherman et al., 2003), it was hypothesized that daily smokers would show more positive implicit affective reactions to smoking-related cues than non-smoking-related cues, but that occasional smokers would show no difference between the smoking and non-smoking stimuli. The AMP was used as the implicit affective paradigm in the current study based on evidence of its enhanced reliability and validity over other implicit measures (Payne et al., 2005). Second, the content of the pictures was manipulated to determine whether those that depicted an individual interacting with a smoking-related object were judged differently from those that depict smoking-related objects by themselves (Forestell et al., 2011; Dickter & Forestell, 2011). Because college student smokers tend to be social smokers (Moran et al., 2004), we expected that differences in implicit affective responses between the smoking-related and the neutral cues would be greater for the active than for the inactive cues. Finally, motivations for smoking were measured to determine whether they were related to implicit affective responses towards active and inactive smoking-related stimuli. Previous research has found that the more college student smokers indicate smoking for positive reinforcement, negative reinforcement, and cognitive enhancement, the more positive their implicit affective response towards smoking-related cues (Payne, Govorun, & Arbuckle, 2007; Payne, McClernon, & Dobbins, 2007).

2. Method

2.1. Participants

Fifty eight (15 females) undergraduates at a medium-sized liberal arts college who reported smoking on an occasional to daily basis ($M = 3.59$ cigarettes per day, $SD = 3.73$ cigarettes per day) were recruited either through an online database and provided with credit in their introductory psychology course or through flyers and paid $10 for their participation. The mean age of participants was 19.75 years ($SE = 0.20$, Range = 18–24 years). All procedures were approved by the school's Protection of Human Subjects Committee, and written informed consent was obtained from each participant.

2.2. Materials

2.2.1. Stimuli

Prime pictures consisting of 40 color photographs were presented, which consisted of 20 smoking-related and 20 non-smoking-related neutral pictures which were matched on various visual properties such as color, brightness, and object to the smoking-related pictures (Forestell et al., 2011). Half of the pictures were active in that they depicted a person interacting with the stimulus, whereas the remaining pictures were inactive, in that they consisted of the stimulus alone. All images were successfully pilot-tested with 10 non-smoking undergraduates to ensure that participants could identify their contents and judge whether or not they were smoking-related. The average accuracy rate for smoking and non-smoking-related stimuli was 98% ± 0.08 (Range: 90%–100%). The target picture stimuli for the computer task were 120 Chinese pictographs which were selected because of their neutral content, and have been used in previous studies as targets (*e.g.*, Payne et al., 2005; Payne, Govorun, & Arbuckle, 2007; Payne, McClernon, & Dobbins, 2007).

2.2.2. Reaction time task

The Affect Misattribution Procedure (AMP) was developed to measure participants' implicit affective responses to presented primes (Payne et al., 2005) and was previously used to examine

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non-smokers' and smokers' implicit affective responses to smoking-related and non-smoking-related stimuli (Payne, Govorun, & Arbuckle, 2007; Payne, McClernon, & Dobbins, 2007). The AMP consists of a presentation of a prime for 75 milliseconds (ms), followed by a blank screen for 125 ms, a Chinese pictograph for 100 ms, and a black and white masking screen. The masking screen remains on the monitor until a response from the subject has been made. In the current study, the primes were pictures of smoking-related and non-smoking-related pictures. Participants indicate whether the pictograph was pleasant or unpleasant by pressing one of two keys on a computer keyboard. There were 160 trials presented to participants during the AMP.

2.2.3. Questionnaires

A general smoking questionnaire asked about the current smoking habits of the participants such as how long they have been smoking, how frequently they smoke per day and per week, and for all but 6 of the participants, how long it had been since they last smoked.

In addition, the participants completed the Wisconsin Inventory of Smoking Dependence Motives questionnaire (WISDM-68), which is a multidimensional measure of dependence that includes 13 subscales (Piper et al., 2004). For the current study, we measured 10 of these: affiliative attachment, automaticity, cognitive enhancement, craving, cue exposure/associative processes, loss of control, negative and positive reinforcement, social/environmental goals, and tolerance. Sample questions include "smoking makes a good mood better" (positive reinforcement), and "if I always smoke in a certain place it is hard to be there and not smoke" (cue exposure/associative processes). Each question was answered on a 7-point Likert scale ranging from "not true of me at all" to "extremely true of me."

Participants were also asked if they had any familiarity with the Chinese language, given that the Chinese pictographs used in the AMP would not necessarily be neutral stimuli for those with expertise in Chinese (Payne et al., 2005).

2.2.4. Carbon monoxide monitor

A carbon monoxide BreathCO monitor (Vitalograph, Lenexa, Kansas), which assesses biochemical changes resulting from exposure to cigarette smoke, was used to measure recent smoking behavior in participants.

2.3. Procedure

All experimental sessions were conducted between the hours of 10:00 am and 12:00 pm to minimize differences in levels of nicotine craving, which have been shown to temporarily increase attention to smoking-related cues (Sherman et al., 2003). The sessions were conducted with groups of three to four participants. Upon arriving at the laboratory, carbon monoxide levels were recorded to assess previous smoking behavior. Participants were then seated at computer stations with privacy walls and given instructions to complete the AMP. Specifically, in line with AMP specifications (Payne et al., 2005), participants were asked to disregard the priming pictures and to rate only the pictographs as pleasant or unpleasant by pressing the corresponding key on the keyboard. All participants completed the AMP within 7 min. After the computer task, they completed the questionnaires online and were then debriefed. Participation in the study took a total of approximately 40 min.

3. Results

3.1. Participant characteristics

Of the 58 participants recruited, five were excluded because they failed to comply with experimental procedures by choosing either "~~more~~ pleasant" or "unpleasant" for all the trials ($n=3$), had slow reaction times (>1.5 s; $n=1$), or had only been smoking for one month ($n=1$). The remaining 53 participants were separated into two smoking groups: daily smokers (those who smoked at least one cigarette per day; $n=34$) and occasional smokers (those who did not smoke everyday; $n=19$). Compared to occasional smokers, daily smokers were significantly older ($M=19.21$, $SE=0.27$ *vs.* $M=20.06$, $SE=0.25$, $t(51)=3.37$, $p<0.001$) smoked more cigarettes per week ($M=4.37$, $SE=0.49$ *vs.* $M=33.47$, $SE=4.60$, $t(52)=8.55$, $p<0.001$), reported smoking more recently (55.69 h, $SE=25.17$ *vs.* 7.00 h, $SE=2.49$, $t(46)=2.17$, $p<0.02$), and had higher carbon monoxide levels ($M=0.42$, $SE=0.19$ *vs.* $M=5.79$, $SE=1.05$, $t(52)=8.55$, $p<0.001$). None of the participants reported any familiarity with Chinese.

3.2. Implicit AMP responses

As in ~~Payne, Govorun, and Arbuckle (2007);~~ Payne, McClernon, and Dobbins (2007) ~~studies,~~ implicit affective responses to smoking and non-smoking trials were determined by calculating the average proportions of pleasant responses from the AMP for smoking and non-smoking trials for each participant. To determine whether the daily and occasional smokers differed in their implicit affective responses to the active stimuli, proportion responses were analyzed using separate mixed analyses of covariance (ANCOVA) with Prime Type (smoking *vs.* non-smoking) as the repeated measures factor and Smoking Group (occasional *vs.* daily smokers) as the between-subjects factor and CO reading as the covariate. As shown in Fig. 1, analyses of the active stimuli revealed a significant Prime Type × Smoking Group interaction, $F(1, 50)=5.45$, $p<0.03$, $\eta^2=0.098$. Simple main effects analyses indicated that the daily smokers had a higher proportion of positive responses ($M=0.65$, $SE=0.04$) to the smoking-related cues than to neutral cues ($M=0.54$, $SE=0.04$, $t(33)=2.12$, $p<0.01$), whereas occasional smokers showed no significant differences in response to smoking cues ($M=0.47$, $SE=0.06$) versus control cues, ($M=0.60$, $SE=0.05$, $t(18)=1.65$, $p>0.10$). Similar analyses conducted on the proportion of responses to the inactive stimuli failed to reveal a significant Smoking Group × Prime Type interaction ($p>0.32$), indicating that participants' implicit affective responses to the inactive smoking and control cues did not differ as a function of their smoking habits.

3.3. Relationships between AMP and individual difference measures

Relative differences between participants' implicit affective reactions to smoking and non-smoking cues on the active trials were determined by calculating AMP difference scores for each participant that subtracted the proportion of pleasant responses on active non-

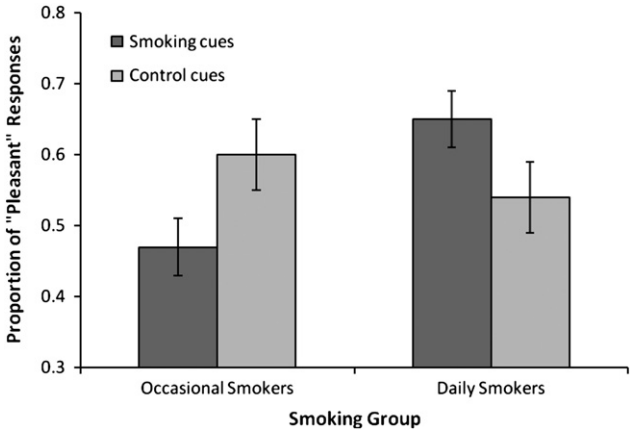

Fig. 1. Proportion of "pleasant" responses in the AMP to active smoking and control cues as a function of smoking group. Error bars represent standard errors of the mean.

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smoking trials from the proportion of pleasant responses on active smoking trials. A similar difference score was calculated for the inactive trials. A higher value on the difference scores indicated more positive implicit affective responses to smoking pictures relative to non-smoking pictures. Separate correlational analyses were then conducted for active and inactive AMP difference scores to examine whether implicit affective scores to smoking cues were related to individual differences in smoking behavior and motivation.

3.3.1. Active AMP difference scores

Because the number of cigarettes smoked per week was positively skewed, we log transformed the raw values (as in ~~Payne, Govorun, & Arbuckle, 2007;~~ Payne, McClernon, & Dobbins, 2007). The active AMP difference score was marginally correlated with the number of cigarettes smoked per week, $r = 0.26$, $p = 0.06$, demonstrating that heavier smokers tended to display more of an implicit preference for smoking-related relative to non-smoking-related pictures. As shown in Table 1, the AMP difference score was also positively correlated with the cognitive enhancement dimension of the WISDM and marginally negatively correlated with the automaticity of the WISDM. No other correlations were significant.

Because ~~Payne, Govorun, and Arbuckle (2007);~~ Payne, McClernon, and Dobbins (2007) found that subjective withdrawal was associated with AMP scores in smokers, we determined whether those who had abstained from smoking longer had higher AMP scores. When all of the smokers were included, this analyses failed to reach significance ($r = -0.20$, $p > 0.15$). Because occasional smokers may take longer than daily smokers to suffer from withdrawal (or some may not suffer from withdrawal at all; i.e., Shiffman, 2009), another analysis which included only daily smokers was conducted which also failed to reach significance ($r = -0.02$, $p > 0.90$).

3.3.2. Inactive AMP difference scores

Although the inactive AMP difference score was not correlated with the frequency of smoking behavior, as shown in Table 1, responses to the inactive stimuli were correlated with cognitive enhancement as well as positive and negative reinforcement. Thus, although smokers showed neutral implicit responses on average to the inactive stimuli, the subset of smokers who experienced more cognitive enhancement, as well as more positive and negative reinforcement responded more favorably to the smoking cues. No other correlations were significant.

Table 1
Correlations between AMP difference scores and measures of smoking frequency and dependence among occasional and daily smokers ($n = 53$).

Measure	Active	Inactive
CO [ppm]	0.16	−0.04
Smoke freq [# cigs/wk]	0.26†	0.13
WISDM dependence scales		
Affiliative attachment	0.00	−0.11
Automaticity	−0.26†	−0.14
Cognitive enhancement	0.27*	0.35**
Craving	0.16	0.17
Cue exposure and associative processes	0.13	0.08
Loss of control	0.08	0.05
Negative reinforcement	0.12	0.41**
Positive reinforcement	0.16	0.37**
Social and environmental goals	−0.21	−0.07
Tolerance	0.03	0.02

† $p = 0.06$.
* $p < 0.05$.
** $p < 0.01$

4. Discussion

The current study was designed to address several goals. First, implicit affective responses were examined to determine whether differences between emotional responses to smoking-related stimuli and non-smoking-related stimuli would differ as a function of smoking group (i.e., occasional *vs.* daily smokers). Second, the stimuli were manipulated to determine whether implicit affective responses to smoking-related stimuli depended on whether the stimuli depicted a person interacting with the smoking object (i.e., active) compared to stimuli with the object alone (i.e., inactive), due to evidence that individuals process active and inactive smoking-related stimuli differently (Forestell et al., 2011). Lastly, motivations for smoking were measured to determine whether they were related to implicit affective responses towards active and inactive stimuli. Consistent with the hypotheses, daily smokers responded more positively to smoking-related cues than control cues for active cues but not inactive cues. In addition, occasional smokers' implicit responses to the smoking and control cues did not differ regardless of whether the cues were active or inactive. Finally, motivations to smoke were differentially associated with affective responses to active and inactive cues.

These results provide preliminary evidence that previous inconsistencies in the literature regarding smokers' implicit affective responses to smoking-related cues may be attributed to two possible explanations. First, smokers do not appear to be a homogeneous group in terms of their implicit affective responses to smoking-related cues. Because studies examining responses to smoking-related stimuli typically group all smokers together (*e.g.*, De Houwer, Custers, & De Clercq, 2006; ~~Payne, Govorun, & Arbuckle, 2007;~~ Payne, McClernon, & Dobbins, 2007; Sherman et al., 2003; Swanson et al., 2001), a great deal of variability in implicit responding occurs, potentially leading to the lack of an effect in responses between smoking and non-smoking stimuli. Indeed, when we separated the smokers in the current study by their smoking frequency, daily smokers showed more positive affective responses to the active smoking-related cues relative to the active non-smoking-related cues, whereas the occasional smokers' responses resembled those found by ~~Payne, Govorun, and Arbuckle (2007);~~ Payne, McClernon, and Dobbins (2007), with no differences between smoking and non-smoking cues. Thus, the failure of previous studies to examine subgroups of smokers may have led to the inconsistencies ~~between studies~~ in smokers' affective responses to smoking and control cues.

It is important to note that although ~~Payne, Govorun, and Arbuckle (2007);~~ Payne, McClernon, and Dobbins (2007) reported that smokers' implicit affective ratings of smoking-related stimuli did not differ from those of control stimuli, they showed that AMP difference scores increased as smokers became more withdrawn. These findings suggest that daily smokers' implicit responses may have been driven not by their daily smoking frequency per se, but instead by their subjective feelings of withdrawal. Although measures of withdrawal were not collected in the present study, participants indicated the amount of time since they smoked their last cigarette. Because previous research has shown that smokers experience more withdrawal the longer they abstain from smoking (Leatherdale & McDonald, 2005; Stromberg et al., 2007), one might expect that if withdrawal affected AMP responding to smoking cues, the amount of time since smokers last smoked should be correlated with their AMP scores. However, this correlation did not reach significance in the present study~~,~~ for neither the entire sample nor for the daily smokers alone. It is possible that because all of the sessions were conducted in the morning, many of the daily smokers were not yet craving nicotine, resulting in reduced variance in withdrawal. Future research should examine how withdrawal and smoking frequency may interact to affect implicit responses to smoking-related cues.

Second, the types of cues used in these paradigms are important in examining implicit responses to smoking cues. That is, daily smokers'

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differential responses to smoking relative to non-smoking cues were only present for active stimuli, and there were no differences in responses to the inactive stimuli for either smoking group. Again, this finding provides evidence that may help explain some of the inconsistencies found in previous studies that have included both active and inactive stimuli (*e.g.*, ~~Payne, Govorun, & Arbuckle, 2007;~~ Payne, McClernon, & Dobbins, 2007; Sherman et al., 2003). That is, the use of inactive stimuli in previous work may have diluted the effects of the active stimuli. The results of the current study imply that the presence of humans interacting with the smoking-related objects makes the image more hedonically positive for daily smokers, but not for occasional smokers. Because previous research suggests that college students tend to be social smokers (Moran et al., 2004), it is likely that through greater exposure to social situations that involve smoking, daily smokers have developed positive associations not just for the cigarettes themselves but for the social context in which smoking behavior occurs~~,~~ relative to occasional smokers.

Whether increases in smoking frequency result in more positive attitudes towards active smoking-related stimuli over time or, alternatively, more positive attitudes towards smoking-related cues induce increases in smoking causing occasional smokers to eventually become daily smokers is a topic that warrants future research. Previous neurobehavioral models of addiction suggest that through continued smoking activities, some occasional smokers may learn to like cigarettes and their associated context more. This positive association, coupled with the dopamine release from the nucleus accumbens caused by prolonged use, may eventually lead to drug wanting and dependence, commonly seen in daily smokers (Robinson & Berridge, 1993, 2001). Understanding more about how different groups of smokers respond implicitly to smoking-related cues will help inform such models of addiction.

Consistent with ~~Payne, Govorun, and Arbuckle (2007);~~ Payne, McClernon, and Dobbins (2007) findings, individual differences in smoking motivations were also associated with AMP responses. In the current study, significant correlations were found between implicit responses to the smoking cues and dependence motives as measured by the WISDM (Piper et al., 2004). Specifically, cognitive enhancement was significantly associated, and automaticity and frequency of smoking behavior were marginally associated, with participants' AMP difference scores to the active stimuli. These results suggest that the more cognitive enhancement they derive from smoking (i.e., increased concentration and focus), the less automatic their smoking is (i.e., smoking without awareness or intention), and the more they smoke, the more they implicitly preferred the smoking-related stimuli over the non-smoking-related stimuli. Correlations were also found between AMP scores for inactive cues and cognitive enhancement, negative reinforcement, and positive reinforcement suggesting that although those with higher nicotine consumption (i.e., daily smokers) ~~do~~ not respond more positively to the inactive smoking cues than those who smoke less (i.e., occasional smokers), the subset of occasional and daily smokers who derive more cognitive enhancement and reinforcement from smoking respond more positively to the inactive stimuli. For these participants, smoking-related objects such as cigarettes, the sight of lighters and ashtrays alone may serve to perpetuate smoking behavior above and beyond that of physiological effects of nicotine (*e.g.*, Tiffany, 1990). Whether responses to these smoking-related stimuli serve as a predictor of addiction is a topic for further investigation.

There are several unanswered questions that future research should address. First, this study was designed to examine differences between active and inactive stimuli but did not examine differences between the types of objects or the interactions between people interacting with the objects in these pictures. It is possible, for example, that active stimuli that involve a cigarette in a person's mouth may be processed differently than stimuli that depict a cigarette in a person's hand. Similarly, it may be that pictures of different types of objects (i.e., cigarettes, lighters, ashtrays) are processed differently from one another. Work by Sherman et al. (2003~~)~~; Study 1) found that smokers had more positive implicit responses to "sensory" stimuli that depicted burning cigarettes than the stimuli themselves, suggesting that differences in processing may exist as a function of how the smoking-related stimuli are portrayed. Finally, previous research has suggested that experiences with parental smoking behavior and attitudes towards smoking may affect implicit responses to smoking-related stimuli (*e.g.*, Andersen et al., 2002). Specifically, children who have a parent who smoke respond more positively to smoking-related stimuli (i.e., the odor of cigarettes) than children without a smoking parent, although this response is mediated by the context in which the parent smokes (Forestell & Mennella, 2005). More recent research has demonstrated that non-smoking college students with at least one smoking parent displayed an implicit attentional bias to smoking-related stimuli (Forestell et al., 2011). These findings suggest that responses to smoking-related cues may vary as a function of parental smoking behavior, and future research should examine how developmental experiences may lead smoking-related stimuli to become associated with more positive affective reactions and may lead to smoking behavior.

This study was limited in several important ways. First, there was a relatively small sample size and findings should be interpreted with caution. Future work should aim to replicate this study. Second, this study was specifically designed to examine college students' implicit reactions to smoking-related cues and may not necessarily generalize to other age groups. A fruitful avenue for future research would be to explore if these effects generalize to adult smokers who ~~had~~ smoked for a considerably longer time than college-age smokers who have been smoking for a relatively short time. In addition, future work should address potential gender differences in implicit affective reactions to smoking-related cues, as the current study did not have enough female participants to make an appropriate gender comparison.

5. Conclusions

The current findings suggest that there are important differences in implicit affective responses to smoking cues between subgroups of college-age smokers, and that their responses differ as a function of whether primes contain human elements or not. One potential practical implication of these findings is the development and implementation of cessation techniques for smokers. That is, smoking cessation programs typically focus on the physiological or psychological symptoms of which individuals are explicitly aware. The current research suggests that these programs should consider the positive implicit associations that daily smokers may have for active smoking-related stimuli that contribute to the maintenance of their addiction. This research also suggests that it may be important to design specific smoking cessation programs for smokers who may differ in their affective evaluations of smoking. A growing number of young American smokers consider themselves occasional rather than daily smokers (CDC, 2003, 2006), possibly due to the increasing cost of cigarettes and restrictions on smoking (Shiffman, 2009). While for some individuals occasional smoking is a life-long pattern, for some college-age students it is a transitional behavior that escalates to daily smoking (CDC, 2003; Baker, Brandon, & Chassin, 2004). Therefore, it may be important for smoking cessation programs to target occasional smokers before they develop positive implicit affective responses towards smoking-related cues.

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Contributors

All three authors designed the study together. John Haight was responsible for data collection and wrote the first draft of the manuscript. Cheryl L. Dickter and Catherine A. Forestell conducted data analysis and edited the final manuscript. All authors have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

Uncited references

Hammond, 2005
Shiffman, 1986

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