Smoking and the alleviation of stress

A study into mediating factors for the relationship between smoking and stress

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Abstract

Goal. *This study aimed (a) to assess whether smoking reduces stress in non-deprived smokers, (b) to investigate whether the effects of smoking a cigarette on stress can be attributed to attention allocation on positive stimuli and (c) to validate whether the effect of smoking expectancies is fully caused by a placebo effect.* **Design**. *Participants, unaware that smoking was investigated, were placed in a social heavy smoking environment to elicit smoking behavior. Afterwards they received a stressor in the form of a memory test that measured attention allocation and filled in a scale for positive smoking expectancies. These results were compared to the amount smoked and fluctuations of stress.* **Setting**. *Camper built to function as a mobile lab (University of Utrecht, NL).* **Participants.** *Thirty two daily smokers between the ages of 16 and 24 who smoked normally prior to the study.* **Measurements.** *Amount smoked was measured with a micro+ smokerlyzer (Sinefuma, 2010) at the start and end of the session. Stress was measured by the self-manikin scale (Lang, 1995; Lang et al., 1990). A memory test was used to measure relative attention towards stressful or calming pictures from the 'The International Affective Picture System' (Lang & Bradley, 2008). A modified version of Russel's motives for smoking questionnaire (SMQ; Tate et al., 1994) was used to measure smoking expectancies.* **Findings.** (a) *Results indicate that smoking might reduce stress in non-deprived smokers, however, effects of nicotine deprivation cannot be ruled out. (b) Smoking does not appear to have an effect on attention allocation. (c) Placebo effects do not seem to account for the full effects of relative smoking expectancies, indicating there might be individual (biological) differences that underlie the relationship between smoking and stress.*

Introduction

Smoking is recognized as one of the most prominent health risk factors in modern western society. It is associated with increased morbidity and a number of serious illnesses (WHO, 2005). In the Netherlands, where 25% of 15-19 year olds smoke at least 1 cigarette a day (STIVORO, 2009) 29% of smokers who attempt to quit are successful and 64% of all smokers have tried to quit at least once and failed (STIVORO, 2007). This emphasizes the societal importance of effective cessation programs. In order to improve these programs more research into smoking is needed, especially among adolescents since it is during adolescence that most people develop their smoking habits.

An often cited reason for smoking is mood regulation, foremost, smoking is often considered by the general population to have stress alleviating properties (Scales et al., 2009), and this conceivably influences cessation attempts. Many studies have been conducted investigating the relationship between smoking and stress but there are few definitive answers. However, when examining previous research into the relation between smoking and stress, a number of brief observations can be made. First, stress seems to lead to increased smoking behavior (Cherek, 1985; Dobbs, Strickler & Maxwell, 1981; Mangan & Golding (1984); Pomerleau & Pomerleau, 1987; Rose, Ananda & Jarvik, 1983). Second, people tend to believe smoking will help them cope with stress (Scales et al., 2009; O. F. Pomerleau and Pomerleau, 1991). Third, smoking seems to increase average levels of stress over prolonged periods of time (Ogden & Mitandabari, 1997; Wills, Sandy & Yeager, 2002), and finally, smoking seems to give some short-term stress relieve and mood-improvement under the right circumstances (Kassel, 2000). However, many studies into the short-term effects are contradicting, results are paradoxical and whether smoking actually reduces stress beyond the benefits gained from alleviation of deprivation effects is not clear. It has been noted (Kalman, 2002) that studies employing nicotine deprived smokers, meaning daily smokers who were not allowed to smoke for at least a couple of hours, generally find positive effects from smoking due to alleviation of deprivation effects. It still has to be examined if and when smoking has genuine positive effects on non-deprived smokers. As such, the main research question of this study will be ‘Does smoking lead to reduced short term stress in adolescent smokers and what conditions underlie this relationship?’.

Of the many hypotheses on the smoking and stress relationship, some are logically consistent and also have some empirical basis due to previous research findings. This study will focus on three of these hypotheses. The first hypothesis is that smoking reduces stress beyond alleviation from deprivation effects. While it has been well established that nicotine deprived smokers derive direct stress reduction from smoking (Gilbert et al., 1989; Gilbert et al. 2008), it is not clear whether this is simply because they satisfy their addiction or if smoking has actual baseline benefit (Parrot, 1999). Interestingly, some studies that employed non-deprived smokers have not found smoking to reduce stress (Bucley et al., 2007; Herbert, Foulds & Fife-schaw, 2001; Kassel et al. 2007). It is often assumed smoking reduces stress; however, this hypothesis is not conclusively answered yet.

The second hypothesis pertains to an interesting hypothesis for which Gilbert et al. (2008) found support, it suggests that the stress alleviating properties of smoking are mediated by the influence smoking has on attention. It is hypothesized that smoking, like some other drugs, narrows attention and when multiple stressful stimuli are present, facilitates the smoker in focusing on the least stressful one. This model could explain why studies employing mild stressors and studies with distractions have found stronger effects of smoking than studies that used severe stressors or did not have distraction available. While there is some initial empirical support, further verification is still needed.

The last hypothesis is that smoking has a beneficiary effect on stress simply because people believe smoking reduces stress. In the so called 'expectancy effects model', the effect smokers experience from smoking derives directly from their own expectancies about smoking. While a correlation has been clearly demonstrated between smoking expectancy and reduced impact of stressful stimuli (Juliano & Brandon, 2002), it is not certain that this correlation exists solely due to a placebo effect, where benefit is gained due to a strong believe that smoking will help. It is also possible that some people simply receive greater benefit from smoking than others, and in turn, hold stronger positive expectancies about the effects of smoking. A deficiency in previous research into this phenomenon is that nicotine intake has been very explicit, making it impossible to differentiate between expectancy effects moderated by the cognitions of smoking and differences in genuine effects. These findings in the literature led to the formulation of the following hypotheses:

- Does smoking lead to reduced short term stress in adolescent smokers and what conditions underlie this relationship?
- Does smoking reduce stress in non-deprived adolescent smokers?
- Do the effects of smoking and stress correlate with attention allocation towards a stressor or distracter?
- Is a placebo effect fully accountable for the correlation between smoking expectancies and reductions of stress in smokers?

These hypotheses were examined in a semi-experimental setting in an attempt towards a multifaceted theory of the smoking and stress relationship that makes sense of all the seemingly contradictory research findings.

Method

Research design

This study was designed to be integrated with an experimental study into the effects of peer influence on smoking behavior in youngsters between 16 and 24 years old in the Netherlands. Subjects were recruited for that experimental study and by adding additional tasks it was also possible to test the hypotheses of this study. Subjects would be approached at their school and asked to fill in a

questionnaire, those who qualified (students between 16 and 24 years old who smoke at least once a day) were called for an appointment to participate in the experiment. The experiments were coordinated by a researcher from the University of Utrecht with help from a confederate actor, who was a student from either the University of Utrecht or HBO (higher level profession education). The role of the confederate was to act as a student from the HBO who was also participating in the study. Actor and same sex subject were instructed to discuss several music videos by webcam over a Skype video connection (www.skype.com) for 30 minutes. The confederate was instructed to have a friendly demeanor, keep the conversation going and either smoke or not smoke three cigarettes (randomly determined by drawing notes from a box). Based on a previous experiment, it was expected subjects would emulate the smoking behavior to a large degree, resulting in a group of participants who smoked an average of 1.3 cigarettes during this halve hour. Afterwards, webcams were turned off and subjects performed a memory test that measured how well people remembered either stressful or calming pictures and filled in a questionnaire about the degree of positive smoking expectancies. When the questionnaire asked about smoking behavior, the questions were doubled with similar drinking and other substance use questions to subterfuge smoking was the goal of this study. At the start of the session, right before the memory task and at the end of the session, self reported levels of stress were measured. Also, at the beginning and the end of the session the amount of carbon monoxide in the subjects' breath was measured by a smokerlyzer (Sinefuma, 2010) to determine the amount of nicotine intake during the session. While not controlling smoking behavior meant abandoning a true experimental design, it also meant it was possible to examine the effects of smoking when smoking was not explicitly done. And since the stressor followed smoking it was possible to further rule out placebo effects of smoking on stress. Compensation for participating in the experiment was fifteen Euros for both subjects and confederates. This experimental design was approved by the ethical advisory commission of the University of Utrecht.

Participants

Subjects are all MBO (medium level profession education) students studying at ROC's (regional educational centers) between the ages of 16 and 24 (N = 42; M =18.64; SD = 1.76). There were 23 male and 19 female participants. Of these sessions, 32 were suited for analysis. This group consists of 18 males and 14 females between the ages of 16 and 24 (M = 18.81; SD = 1.82). All subjects have reported to smoke at least one cigarette a day and tested positive for smoking the last 48 hours.

Instruments

A scale for amount smoked during the session was created. All subjects took two breath tests with a micro+ smokerlyzer (Sinefuma, 2010), once at arrival and once at the end of the session. This device gave a ppm (parts per million) score for the amount of carbon monoxide particles in the

subjects breath. Smoking distributes carbon monoxide to the blood circulation and it takes about 48 hours of nonsmoking to be completely removed. For an accurate measurement it is needed to wait at least ten minutes after smoking before taking a smokerlyzer test. This is accounted for as it took more than ten minutes to complete the picture task and final questionnaire, after which the final breath test was administered. The first measurement validates participants are daily smokers, and when subtracting the ppm score at the beginning of the session from the ppm score at the end, a variable on a continuous scale is created for how much was smoked during the session, thus measuring the variable 'amount smoked'.

A scale was created to measure levels of stress and fluctuations of stress during the session. Kassel (2000) notes how studies have defined and measured stress in many different ways, making it difficult to compare different research findings. In general, all definitions have in common that stress is defined as an unpleasant emotion that makes people feel tense or pressured. Kassel (2000) proposes that an informed, universally applicable, empirically supported theory of affect is needed in future studies. The self-manikin scale, a two-factor model consisting of continuous scales of valance and arousal (Lang, 1995; Lang et al., 1990) provides such a conception of stress and was used during this study to measure levels of stress. The general notion is that all basic emotions can be reduced to varying degrees of valance and arousal. Someone will be considered to have high levels of stress when he scores low on valence and high on arousal. Valence and arousal are both measured on a 9 point scale. After recoding valence to reverse the meaning low and high scores, it is possible to combine the scores for a stress score between 2 and 18. During the study, stress is measured three times, at arrival, before the picture task and after the picture task. When subtracting the score of the second measurement from the score of the third measurement, a scale for increase of stress during the picture task is created (where a negative score would indicate a reduction of stress). When subtracting stress at the first measurement from the third measurement a scale for increase of stress over the whole session is created. A scale for increase of stress during music task is formed by subtracting the first measurement from the second.

A scale to measure attention allocation on stressful (high arousal/low valance) instead of calming (low arousal/high valence) pictures was constructed. This scale was constructed from the data received on the memory test. During the picture task, participants watched 14 pairs of pictures from the International Affective Picture System (Lang & Bradley, 2008) for eleven seconds on a computer screen. The International Affective Picture System (Lang & Bradley, 2008) is an extensive database of pictures that have been rated on valence and arousal by groups (generally N=100) of people. Every pair had one picture rated as very stressful (low valence, high arousal) and one rated as very calming (high valence, low arousal). Participants received a questionnaire that tested how many of the stressful and calming pictures they remembered. The questionnaire consists of 68 short descriptions of pictures, 28 of which were indeed included in picture pairs and 40 that were not. Halve of the descriptions are of something stressful and halve of something calming. Subjects had to check the descriptions they

recalled seeing. It was examined how many descriptions they checked correctly. In analysis, the stressful and calming descriptions were split to make separate scales for checking boxes correctly within the stressful and calming categories. Subjects received a score ranging from zero (nothing correct) to 34 (everything correct) in both calming and stressful categories. Subtracting the score for the calming category from the score for the stressful category created a variable for relative attention allocation toward stressful pictures. Positive scores indicate more attention on stressful pictures and negative scores indicate more attention on calming pictures.

A scale to assess the positive expectancies about smoking was constructed by translating a modified version of Russel's motives for smoking questionnaire (SMQ; Tate et al., 1994). The version was translated to Dutch by two different researchers and translations were assessed by a third. The scale was based on the three highest-loading items from each of Russel's six factors (Russel et al., 1974) scales, only using the constructs for stimulating and sedative motivation for a total of six questions (*1- I like smoking while I am busy and working hard. 2- I get a definitive lift and feel more alert when smoking. 3- I smoke more when I am rushed and have lots to do. 4- I smoke more when I am worried about something. 5- Smoking calms me down when I feel tense. 6- I light up a cigarette when I feel angry about something.*) on which subjects could answer on a four point scale (*1- Not at all. 2- A little. 3- Quite a bit. 4- Very much so*). When testing reliability by factor analysis, the scale showed a Cronbach's Alpha score of .45. One question (*1- I like smoking while I am busy and working hard*) in particular did not correlate with the others, after removal a 5 factor scale was created with a Cronbach's Alpha of .55. The scores for the five questions were averaged to create a scale for positive smoking expectancies. While a Cronbach's Alpha of .55 is not ideal, it can be seen as acceptable, especially as it has shown reliable in other studies that used larger sample sizes and it is logically consistent (Russel et al., 1974, Tate et al., 1994).

Analysis strategy

First, it is important to examine whether an increase in levels of stress before and after the picture task is found by performing a T-test. This will be compared to changes in stress levels throughout the session.

Second, the relationship between amount smoked and increased stress will be tested by conducting a single linear regression analysis. To control for the effects of nicotine deprivation, tests will also be conducted separately for the subjects that either did or did not smoke during the session. Correlation between amount smoked and number of cigarettes will be tested to examine the reliability of the amount smoked scale.

Third, the relationship between smoking, stress and attention allocation on negative stimuli will be tested by performing a single linear regression for the effects of attention allocation on stress. Then, a regression analysis for the effects of amount smoked on attention allocation will be performed. Also, a multivariate regression analysis for the effects of amount smoked and attention allocation

combined on stress will be conducted. The tests will also be run with only the subjects who smoked at least one cigarette.

Fourth, the relationship between smoking, stress and smoking expectancies will be tested by performing a single linear regression for the effects of smoking expectancies on stress in subjects that smoked. Then, a multivariate regression analysis for the effects of amount smoked and attention allocation combined on stress will be conducted.

Results

Descriptive statistics of the sample group are given in table 1. In some cases, a separate analysis was performed for the subjects who smoked at least one cigarette during the session; the second number in each cell describes that group. Differences in N are due to a substantial amount of missing values in the dataset.

Table 1. *Descriptive statistics divided into whole sample and subjects that smoked at least one cigarette during the session*

Whole sample/smoked at least 1 cig.	N	Minimum	Maximum	Mean	Std. Deviation
Age	32/24	16/16	24/24	18.81/18.79	1.82/1.97
Amount smoked	30/22	-5/-5	10/10	2.21/3.15	3.56/3.56
Cigarettes smoked during session	32/24	0/1	4/4	1.31/1.75	.99/.73
Stress at the start of the session	25/19	2/2	13/9	5.44/5.21	2.61/2.22
Stress before the picture task	27/20	2/2	9/9	4.81/4.85	1.98/1.98
Stress at the end of the session	26/20	2/2	10	5.23/5.25	2.30/2.40
Increase of stress during picture task	26/20	-2/-2	2/2	.30/.40	.97/.99
Attention allocation toward negative stimuli	32/24	-2/-2	9/9	3.53/3.50	2.52/1.97
Positive smoking expectancy	31/24	1.8/2.6	4.4/4.4	3.41/3.45	.61/.48

Does the picture task result in a measurable negative impact on stress?

At the start of the session the mean level of stress was 5.44, after the music task it was 4.92 and at the end of the session it was 5.23. Paired samples T-tests show that differences in stress levels are not significant. Between the start and the end of the sessions the difference is .25 (N = 24; P = .57) between before and after the music task it is .60 (N = 25; P = .09) and between before and after the picture task it is -.31 (N = 26; P = 12).

Does smoking reduce stress in non-deprived adolescent smokers?

A strong correlation was found between carbon monoxide increase during session and cigarettes smoked during session (N = 30, R = .55, P < .01). Linear regression analysis between amount smoked and stress indicates a strong but insignificant *negative* effect of amount smoked on stress (N = 25; Beta = -.20; P =.34). Separate regression analysis of those who did not smoke during the session indicates a very strong *positive* relationship between smoking stress (N = 6; Beta = .57; P =.24), however, it is not significant and there are only 6 subjects that did not smoke, as such, it is not fruitful to further interpret this effect. The same regression analysis for subjects that smoked at least one cigarette during the session showed a very strong *negative* relation between stress and amount smoked (N = 19; Beta -.44; P = .057). Subjects that smoked gained carbon monoxide in their breath during the session (N = 22; *Min* = -5; *Max* = 10; M = 3.16; SD = 3.56) while subjects that did not smoke lost carbon monoxide during the session (N = 8; *Min* = -4; Max = 3; M = -.36; SD =. 2.07).

Do the effects of smoking and stress correlate with attention allocation towards a stressor or distracter?

The link between attention allocation on negative stimuli and stress is very strong but not significant (N = 26; Beta -.32; P = .11). A univariate regression analysis for the effect of amount smoked on attention allocation did not indicate any relationship (N = 30; Beta = -.086; SD = .65). A multivariate model of amount smoked and attention allocation block did not yield significant results (N = 25; Beta -.29; P = .16). Results did not improve when only subjects who smoked during the session were included.

Are placebo effects fully accountable for the correlation between smoking expectancies and reductions of stress when smoking?

Single linear regression analysis for the relation between stress and smoking expectancy was not significant (N = 20; Beta = -.12; SD = .61). However, the univariate model of the impact of amount smoked on stress (N = 19; Beta -.44; SD = .057) does improve greatly when smoking expectancy is added with amount smoked in a multivariate analysis (N = 19; Beta = -.60; SD = .03). A Pearson's correlation test showed that that smoking expectancy and amount smoked do not significantly correlate (N = 29; R. = -.14; SD = .48). A moderation check that adds an amount smoked multiplied by smoking expectancy variable showed no moderation effect (P = .84).

When discussing these results, classifications of effect sizes will be derived from Nijdam (2003) as followed:

Beta	Effect		
<.05	Weak	≥.15	Strong
<.15	moderate	≥.30	Very strong

Discussion

Does the picture task result in a measurable negative impact on stress?

Results do not show significant differences in stress at different parts of the session, this is also true for the picture task. It can be argued, however, that the picture task did elevate levels of stress for a number of reasons. First of all, other experiments have successfully used a similar set-up with pictures to induce stress (Gilbert et al., 2008; Herbert, Foulds & Fife-shaw, 2001) and the pictures in this study have been validated as invoking feelings of low valance and high arousal (Lang & Bradley, 2008). Second of all, results did follow expectations about level of stress fluctuations as it decreased during the pleasant music task and increased during the stressing picture task. Not finding significant findings is more likely a result of low power and an imprecise measurement tool for stress, which will be discussed in the limitations section.

In any case, stronger results for stress fluctuations would have benefited the power of this study and it will be harder to find significant results for the different hypothesis when the main variable does not show significant changes.

Does smoking reduce stress in non-deprived adolescent smokers?

While not conclusively answered, this study shows some support for the hypothesis that smoking reduces stress in adolescent non-deprived smokers. It is, however, possible for relieve from deprivation effects to have played a role in the results. With the whole sample, amount smoked has no significant effect on stress. However, this insignificant finding could be explained by an apparent split between those who smoked at least one cigarette and those who did not smoke during the session. In the group that smoked at least one cigarette, increased smoking does have a very strong effect on stress that is very nearly significant. Results for those who did not smoke show a reversed effect; it seems that more carbon monoxide lost during the session leads to less stress gained during the picture task. This reversed effect in not smokers, however, is not significant and comprises of only 6 subjects and it would not be fruitful to interpret these findings.

This split between those who smoked during the session and those who did not could be explained if relieve from deprivation effects impacted the results. Possibly, some level of nicotine deprivation was present in subjects at the start of the session or 60 minutes is enough to induce deprivation effect. If so, in subjects who smoked, this is relieved by the initial amount smoked, and what is measured during this experiment is the effect of *additional* amounts smoked. In people who did not smoke, only the degree of nicotine deprivation will impact levels of stress. This effect is can be observed by the mean decrease of carbon monoxide in subjects' breath in those who did not smoke and an increase in those who did smoke. It is possible that this studies attempt to examine effects of smoking in non-deprived smokers has resulted in examining the effects in minimally deprived smokers. As this study obfuscated its goal of doing research into the smoking, subjects did not receive explicit instructions about their smoking behavior. Since it was checked whether participants had

cigarettes on them during the session, participants were considered not nicotine deprived when they started the experiment. The assumption was that people who were allowed to smoke before the session would do so if they started experiencing deprivation effects, effectively removing deprivation effects from the study. However, the time it takes for deprivation effects to manifest is not known, and, could possibly manifest immediately after smoking. As degree of deprivation effects were not measured and no control group was used this effect is not known.

However, even if deprivation effects did affect the data, support for the hypothesis that smoking has genuine positive effects is present. In those who smoked, amount smoked did have a very strong negative linear relationship with stress. Subjects were never severely nicotine deprived and the initial amounts smoked would relieve deprivation effects. As such, because greater amounts smoked resulted in less stress, support for the hypothesis that smoking genuinely reduces stress in smokers does exist. However, the precise effects and the time it takes for nicotine deprivation to manifest do require further investigation as many differences in research findings could possibly be explained by this.

Somewhat similar results were found by Parrot (1994) who asked people to report their mood on regular intervals during everyday life to examine the relationship between smoking, urge and deprivation. While people reported lower levels of stress after smoking, these levels would immediately start rising again, indicating the effects of nicotine deprivation are immediate. It was directly after smoking when stress levels were closest to those of non-smokers, indicating that positive effects for smoking could be temporary relieve from deprivation effects.

While relieve of deprivation effects are apparent, positive effects of smoking beyond relieve of deprivation effects are not well documented. Kalman (2002) noted that many differences in research findings can often be explained by the different levels of nicotine deprivation of the subjects. He suggests that a strong linear relationship between stress reduction and nicotine dosage was often found in studies using deprived smokers while finding small, contradictory or ambiguous results in those studies conducted with minimally or non-deprived smokers. A linear effect of smoking on stress in deprived smokers was also found by Gilbert et al. (1989; 2008). This does not, however, necessary implicate smoking actually improves baseline levels of stress, only that nicotine deprived smokers have lower levels of stress after smoking than before. Parrot's nicotine escape model (1999) is based on this assumption: that all positive effects of smoking are the direct or indirect result of relieve from deprivation effects. He states that it is by repeated pairing of distress caused by nicotine withdrawal and smoking-induced alleviation of distress, smokers start to view stress as a stimulus signaling that smoking will reduce stress, eventually making it reinforced behavior. The actual positive change is supposedly caused by (1) relieve from nicotine withdrawal and (2) the conditioned pairing of smoking and anxiety relieve. As this study tested the effects of smoking directly after smoking had occurred, conditioned pairing of smoking and anxiety relieve is accounted for. Conversely, while it seems correct to attribute much of the stress alleviating properties of cigarette smoking to alleviation of

deprivation effects, not all effects of smoking can be accounted for this way. As Kalman (2002) noted, a number of studies (Gilbert & Spielberger, 1987; Jarvik et al., 1989) indicate smoking does have baseline beneficial properties and shows measurable physiological effects in never smokers. One study, for instance, compared placebo controlled nicotine injections in non-smokers and found that there was an increase in heart-rate, a change in brain activity and a change in subjective feeling when people were injected nicotine (Foulds et al., 1994).

This study, with the finding of reduced stress in those who smoked most, supports the hypothesis that smoking has a genuine positive effect on non deprived smokers besides alleviation of deprivation effects. However, as deprivation effects are not wholly accounted for, care should be taken in interpreting these effects.

Do the effects of smoking and stress correlate with attention allocation towards a stressor or distracter?

This study found no evidence that the effects of smoking on stress correlate with attention allocation towards a stressor or distracter. Attention on negative stimuli did show to increase stress and a very strong albeit not significant effect of attention allocation on stress was found. A larger N arguably might have led to a significant result. This effect, however, is an independent effect of the relative attention allocation on positive or negative pictures. No relationship was found between amount smoked and attention allocation, indicating smoking does not influence attention allocation directly. Tests for an interaction effect were also negative; indicating that smoking also does not affect the relationship attention allocation has on increase of stress. These results mimic those of Herbert, Foulds & Fife-schaw (2001), who's results also failed to support the idea that smoking has anxiety-reducing or attention-enhancing properties in non-deprived smokers through channeling of attention on positive stimuli.

It has been noted (Kassel, 2000) how differences between experiments in choice of stressor type and environmental settings often lead to different findings. One general tendency seems to be that experiments using mild or distal stressors elicit more stress reduction from smoking than those who employ intense or proximal stressors. Kassel and Unrod (1997) noted that studies using very severe stressors regularly found no difference in stress levels when accounting for stress alleviation effects. The hypothesis was that nicotine could focus attention on external stimuli, decreasing focus on internal mood states like stress, effectively reducing the effects of a negative stressor, even more so when accompanied by distracting stimuli. A number of studies have been performed that provided some indirect data for this hypothesis**,** and while some studies indicated preliminary support (Bucley et al., 2007; Jarvik et al., 1989; Kassel & Unrod, 2000), others did not (Gilbert et al., 1989).

One experiment was specifically designed to test the hypothesis that smoking, like some other drugs, narrows attention and when multiple stressful stimuli are present, facilitates the smoker in focusing on the least stressful one. This placebo controlled experimental study, (Gilbert et al., 2008)

where smoker and non-smoker groups were exposed either to only emotionally negative pictures or positive and negative pictures simultaneously, found positive results. Some positive independent effects of smoking and distractions were found but much stronger effects were found in the group that both smoked and had distractions. Two problems with this study were that (1) it was not measured whether the positive pictures really distracted from the negative pictures or if the positive pictures had their own separate and counteracting positive effect and (2) they used deprived smokers, which means nicotine withdrawal escape cannot be ruled out as a factor influencing results. The current study aimed to further investigate the hypothesis by measuring attention allocation directly and using non deprived smokers. However, like Herbert, Foulds & Fife-schaw (2001), no results were found for a direct effect of smoking on attention allocation or an interaction effect. It is possible that being nicotine deprived or being relieved of nicotine deprivation does have some effect on stress through attention, as this was a key difference in studies. Results could be explained if the hypothesis were reversed; instead of nicotine focusing attention on positive stimuli, it could be that nicotine deprivation focuses attention on negative stimuli. This could also explain the common finding that smoking generally elicits more reductions of stress when coupled with mild stressors than with severe stressors. Further research aimed at the effect of attention allocation in deprived smokers will be needed to test this hypothesis.

However, the hypothesis that smoking has a genuine positive effect on stress through attention allocation on positive stimuli or by an interaction effect of attention and smoking on stress cannot be supported by this study.

Is a placebo effect fully accountable for the correlation between smoking expectancies and reductions of stress in smokers?

This study does not support the hypothesis that a correlation between smoking expectancies and reductions of stress when smoking can be fully explained by placebo effects. As the difference between placebo-effects and genuine effects of smoking was examined, all subjects who had not smoked during the session were excluded from analysis. Results did not indicate a correlation between stress and smoking expectancies. This indicates smoking expectancies have no effect on reduction of stress when smokers are not aware of their smoking behavior and smoking is done before the picture task. Previous studies consistently found effects of smoking expectancies when subjects smoked. That no independent effect is found for smoking expectancies indicates placebo effects were indeed nullified for this study. However, while amount smoked shows a very strong effect on stress that is nearly significant, a combined model of amount smoked and smoking expectancies has an even greater effect that truly is significant. This indicates that expectancy has no effect on itself, but becomes significant when coupled with amount smoked. As the two factors do not correlate, these results indicate that the increased effects of amount smoked could be the result of something else. Literature indicates that it is possible that differences in smoking expectancies are (partly) caused by actual individual differences in the effects of smoking. Individual subjects will expect more positive effects

from smoking when they have experienced more stress reductions from smoking in the past and will, correctly, expect more positive effects from smoking in the future.

Literature does suggest a number of ways in which inherited individual biological and neurological differences can play an important role in determining and understanding the effects of smoking on stress (Gilbert et al., 2008; Powel et al., 2002). First, there appears to be an effect of smoking on Monoamine oxidase inhibitors, similar to the effect of many anti-depressants (Fowler, Logan, Wang & Volkow, 2003). Second, it has been proposed that anxiolytic effects of smoking are somehow mediated by dopaminergic action in the nucleus accumbens, a part of the human brain. (Brody et al., 2004). Third, Bucley et al. (2007) claim nicotine increases dopamine release, which is accompanied with pleasant feelings, making smoking rewarding and addictive. While it is not clear whether significant individual differences derive from this, these is evidence for individual differences that could be subjected to further investigation.

One laboratory study with rats (Acri, 1994) provides evidence supporting the claim that individuals inherently respond differently to nicotine. It appeared that, when comparing no nicotine intake in rats to low or high nicotine intake, only rats who initially display heavy startle responses when stressed have significantly less responses when under influence of nicotine, indicating individual differences could be an important moderating factor in the smoking-stress relationship. While this does not mean humans will have the same response, it does provide some preliminary support for the hypothesis. However, while the effects of individual differences had been speculated on, little to no specific research has been performed in humans to test this and to examine what personal traits or biological differences influence this.

Concerning the placebo effect, while the findings of this study do not contradict the hypothesis that a placebo effect affects the relationship between stress and smoking, it does show that it cannot fully account for the effects of smoking expectancies in previous studies. Pomerleau and Pomerleau (1991) already noted that a link between smoking and reductions of stress are so well entrenched in the lore concerning cigarette smoking that, over the years, they have assumed the status of truisms. This is demonstrated by an earlier study (Jarvik et al., 1989) finding 71% of smokers believed smoking to have stress reducing properties while 9.5% of smokers did not and more recently, a focus-group study performed in America found that virtually all adolescents, smokers and non-smokers, believed smoking to reduce stress (Scales et al., 2009). Interestingly, when Bauman and Chenoweth (1984) asked 1,400 adolescents, most of which had never smoked, about the expected effects of cigarette smoking they found that expected pleasure and relaxation predicted whether people would start smoking.

This has led to many studies examining placebo effects of smoking. One experimental study that compared light smokers to non-smokers found that while high nicotine intake reduced self-reported negative affect, this effect was primarily found in those who expected nicotine to reduce negative affect while no effect of nicotine was found in non-smokers (Kassel et al. 2007). A literature

review into non-smoked nicotine (Kalman & Smiths, 2005) found significant differences for smokers and never-smoker in placebo as well as real nicotine dosages. These findings suggest that smokers and never-smokers are different in cognitions about nicotine effects and this could influence the effects of smoking. A study by Juliano and Brandon (2002) divided participants in different conditions, one condition where people were *given* either high or low nicotine dosages and the other condition was that people were *told* they got either high or low nicotine dosage. It was found that both high nicotine dosage and the idea of smoking nicotine cigarettes independently reduced feelings of anxiety, also indicating separate effects for smoking and placebo effects. Juliano and Brandon (2002) also found that telling people they had high or low nicotine dosage had more effect on people who expected more positive effects from smoking, These findings support the idea that a placebo effect exists, but that an interaction between amount smoked and smoking expectancies also exists.

As such, the assumption that a placebo effect is fully accountable for causing the correlation between smoking expectancies and stress reduction cannot be supported. While previous studies did not aim to test this hypothesis, preliminary evidence did already exist. The deficiency in previous research is that nicotine intake had been explicit, making it impossible to differentiate between expectancy effects moderated by the cognitions of smoking, or, placebo effects, and genuine differences in the effects of smoking people experience. Results of this study indicate that when smokers are not aware of their smoking behavior (meaning that a placebo effect is not possible), smoking expectancies do still affect the relationship amount smoked has on stress. While this does not negate the possibility of a placebo effect, it does show that placebo effects do not fully account for the effects of smoking expectancies and suggests that individual differences might partly explain the differences in smoking expectancies.

Limitations and opportunities

This study has a number of limitations. First of all, the power of the study was lower than desirable. This means a higher probability of type 2 errors, where an effect does exist but no significant results are found in the data. Due to this, occasionally, the argument for the existence of an effect is made when strictly none was found at a reliability interval of 5 percent. This is done in cases where nearly significant effects follow expectations logically and at least a strong effect size is found.

Primary reason for the low power is the low N. This is caused, first, by the fact that the experiment into peer influence that this study was integrated with had enough power for its analysis before this study did. As such, the experiment was halted and this study did not garner more data. Second, there was an extremely high non-response rate, primarily with participants not showing up on the agreed date. Thirdly, quite a few subjects' data could not be used as smokerlyzer tests and stress tests were on occasion performed erroneously.

The power of this study was also hindered by an imprecise measurement tool for stress, probably leading to insignificant findings for fluctuations of stress during the session. The stress scale

comprised of a self reported measurement of valence and arousal. Subjects choose from a row of pictographs those depictions of emotions that best represented their current feeling. While this has shown to being a reliable scale, due to the simplistic nature of measurement it is possible many people just checked the same boxes without much thought about changes in their affect. This argument is based on the observed quickness with which subjects often checked the boxes during the session and on the fact that 46% of the time people did not indicate any change in levels of stress. This danger is present for all subjective indices of stress, but even more so when scales are very basic and consist of few scales.

An objective scale for stress is, however, not a better choice when examining stress and smoking due to a common paradoxical finding. While smoking often decreases stress on subjective scales like self-reported questionnaires, it increases stress on objective indices like heart rate, cortisol output, corrugator electromyograph (EMG) and skin conductance. (Bucley et al., 2007; Gilbert, Estes & Welser, 1997; Gilbert & Spielberger, 1987; Nesbitt, 1973; Pomerleau & Pomerleau, 1990). This is believed to be caused by independent physiological effects of cigarette smoking that resemble the physiological indices commonly used to measure stress. As such, it is needed to employ subjective scales rather than objective physiological indices to measure stress. Stress is ultimately a subjective phenomenon and objective scales can only measure physiological side-effects that normally accompany the subjective feeling of stress.

Second of all, while this study tested hypothesis about causal relationships, it does not have a true experimental design. There are no a control groups, and technically this study only examines correlation, not causation. However, the tests and conclusions follow activities logically; for instance, smoking was done before examining attention allocation, making a strong argument that this study examines the causal connection between the effects of smoking on attention. The choice for no control groups was made due to a low expected number of participants and the high probability effect sizes would be small. Using control groups would effectively split the participants for each hypothesis that is going to be tested in halve, making it increasingly difficult to find small effects.

It would, however, have been ideal if nicotine deprived and non-deprived smokers as well as non-smokers had been a part of this study. This was not possible due to the integration with the other study. While this study did use non-deprived smokers, results would have greater meaning when it had been possible to compare the findings to nicotine deprived smokers and non-smokers. A control group of deprived smokers would have been especially useful as data indicates that relieve from deprivation effects might have affected the data, even when smokers were allowed to smoke before the sessions.

The positive link between amount smoked and stress found in subjects that did not smoke (thus losing carbon monoxide during the session) and negative link found in subjects that did smoke might have resulted from differences in relieve from deprivation effects. While this effect could also be explained by the very small sample size of subjects that did not smoke, an influence of deprivation effects is likely, and at the very least cannot be ruled out. If deprivation effects were a factor, not

smokers would have suffered the effects of light nicotine deprivation while smokers would have relieved them while also benefiting from cigarette smoking. To account for this, all tests have been conducted twice, once for the whole sample group and once including only those who smoked at least one cigarette during the session. The goal of this study was to examine whether smoking leads to genuine reductions of stress in non deprived smokers. In tests where subjects that did not smoke are included, some degrees of deprivation effects might have polluted the results.

An opportunity for this study is that a study investigating the effects of smoking on stress is rarely done with a population as young as this one and never been done (as best to the authors knowledge) in the Netherlands. While very little comparative research into this area exists, there is data suggesting that the age of a smoker and amount of time someone has been smoking could impact the way smoking alleviates stress. It has been suggested (Dahl, 1996; Rose, Ananda & Jarvik, 1983) that due to specific development of the adolescent brain, adolescents in particular, might be more susceptible to the arousing properties of nicotine, and this might reduce stress. This suggests that examining different age groups could lead to different results. While this study does not compare different age groups, it can be stated that the data collected does not show abnormal results for this age group that is normally underrepresented in studies.

Implications

In minimally deprived smokers who smoked at least one cigarette, a strong negative effect was found from amount smoked on stress, indicating that smoking has genuine stress reducing properties in smokers. However, it is unknown what the term minimally deprived smoker really means. While the study intended to use non deprived smokers, data suggests some deprivation effects might have affected the data. This leads to two important avenues of future investigation. On the one hand, it needs to be examined if smoking reduces stress in non-deprived smokers (while controlling for placebo effects). On the other hand, deprivation effects need to be examined more thoroughly. Specifically how long it takes for deprivation effects to take effect and how long it takes for effects to become severe. It is possible that a non deprived smoker only exists at the moment of smoking and that this has affected the results of many studies.

It has not been shown that smoking has any direct effect on attention and the effect of attention towards positive stimuli on stress is also not influenced by smoking. While this hypothesis can be rejected, it is not exactly clear why Gilbert et al. (2008) did find an effect. This could be explained by the different levels of nicotine deprivation but this needs further investigation. Also, a new hypothesis will need to be formulated and tested for the common finding that experiments employing mild stressors find more effects of smoking on stress than experiments that have severe stressors.

Placebo effects have not been found to account for the complete effects of smoking expectancy, indicating that the effects found on stress for difference in smoking expectancy could be explained by genuine differences in the effects smoking has on people. In turn, this could indicate that

(biological/neurological) individual differences are an important aspect of the smoking and stress relationship. Future investigation should focus on determining what differences are significant and how great their effects are. The 'Situation x Trait Adaptive Response model' (Powell et al., 2002), a theoretical framework that incorporates individual differences in combination with other factors might be a good framework on which to base future studies.

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