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Cigarette smoking is associated with difficulties in the use of reappraisal for emotion regulation

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ABSTRACT

Background: Negative emotions can promote smoking relapse during a quit attempt. The use of cognitive reappraisal to self-regulate these emotions may therefore aid smoking cessation. Determining whether smokers exhibit difficulties in the use of reappraisal, and which factors are associated with such difficulties, may aid smoking cessations.

Methods: 50 smokers and 50 non-smokers completed an online reappraisal task in which they either reappraised or naturally experienced emotions induced by negatively- and neutrally-valenced images that presented situations in either the 1st-person or 3rd-person perspective. Participants also completed the Difficulties in Emotion Regulation Scale (DERS).

Results: Compared to non-smokers, smokers were less successful in using reappraisal to self-regulate emotions elicited by negatively-valenced images (but not neutrally-valenced images). Importantly, this effect was only true for images that were presented in the 1st-person (but not 3rd-person) perspective. Contrary to predictions, there were no group differences in DERS scores.

Conclusions: This study provides the first evidence that smokers experience difficulties in the use of reappraisal, particularly in situations that appear to be happening to themselves. Because the use of this regulation technique may help smokers to quit, improving smokers' abilities to use reappraisal, particularly during negatively-valenced situations that directly influence the smoker, may aid smoking cessation.

1. Introduction

Tobacco smoking remains one of the leading causes of disease and death worldwide, and contributes to more than 8 million deaths per year around the globe (World Health Organization, 2019). Many smokers fail to refrain from smoking during a quit attempt because they are unable to tolerate rapid increases in negative emotions that occur spontaneously during abstinence or in reaction to negatively-valenced situations (Juliano and Brandon, 2002; Shiffman and Waters, 2004). Because these negative emotions can be relieved by smoking (e.g., Faulkner et al., 2017), these emotions can promote continued cigarette use (Shiffman and Waters, 2004). The use of cognitive strategies to help smokers self-regulate these negative emotions may therefore aid smoking cessation.

Emotion regulation refers to the use of cognitive strategies to modify the valence and/or intensity of an emotion (Gross et al., 1998). Perhaps the most studied strategy is 'reappraisal', which involves reframing or reinterpreting negative thoughts or situations into more positive ones to alter their emotional impact (Cutuli, 2014). With regards to smokers, the use of this technique during a particularly stressful, anxiety-inducing or negatively-valenced situation may alleviate any ensuing negative emotions, thus reducing the ability of these emotions to promote smoking behaviors. For example, Szasz et al. (2012) asked smokers to either reappraise or naturally experience any emotions that were elicited by smoking-related images, and reported that smokers who reappraised such emotions self-reported lower cigarette craving, lower negative affect and weaker attentional biases to smoking-related cues. Further, smokers who used reappraisal to regulate smoking-related thoughts

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during a week-long period self-reported smoking fewer cigarettes than smokers who simply tried to suppress such thoughts (Beadman et al., 2015).

To optimize smokers' abilities to use reappraisal it is important to determine whether they experience difficulties in using this technique, particularly when trying to regulate negative emotions elicited by non-smoking related cues; currently, studies have only examined smokers' ability to regulate emotions elicited by smoking-related cues, yet situations that contain no smoking-related cues whatsoever may be more commonly-occurring, and can still promote smoking behaviors by eliciting negative emotions (Shiffman and Waters, 2004).

It may be that compared to non-smokers, smokers are less effective at using reappraisal to regulate negative emotions elicited by any type of cue. For example, Faulkner et al. (2020) asked daily smokers and non-smokers to complete the difficulties in emotion regulation scale (DERS; Gratz and Roemer, 2004), a self-report scale that quantifies difficulties in emotion regulation across 6 subscales, each of which are summed to create a total score. The authors reported that, compared to non-smokers, smokers self-reported higher total DERS scores (denoting greater difficulties in emotion regulation). Furthermore, smokers self-reported higher scores on the 'lack of emotional clarity' subscale, which indicates that smokers experience greater difficulties in understanding the nature and/or valence of their emotions. Importantly, the DERS does not quantify difficulties in the use of one particular emotion regulation technique. There is thus a need to determine via an objective (i.e., non-self-report) measure whether smokers experience difficulties in the use of reappraisal. In addition, understanding whether such a deficit (if one exists) is related to a lack of emotional clarity, could aid smoking cessation.

We therefore compared the performance of daily smokers and non-smokers on a task that quantified their ability to use reappraisal to self-regulate emotions induced by negatively- and neutrally-valenced images. Our main hypothesis was that, compared to non-smokers, daily smokers would be less successful in using reappraisal to regulate their negative emotions induced by negatively-valenced (but not neutrally-valenced) images.

Importantly, previous studies that assess reappraisal abilities in this way often present images that present scenes in both the first-person perspective (i.e., in which the viewer is the implied object) and in the third-person perspective (i.e. in which another person is the object), without examining whether this difference in perspective influences responses to such images. This omission is important because this difference in perspective may influence the subsequent recall of the scene and the resulting emotions (see Sutin and Robins, 2008 and Wallace-Hadrill and Kamboj, 2016). We therefore classified images as either 1st- or 3rd-person perspective images, and hypothesized that any group difference in the ability to use reappraisal to self-regulate emotions would be greater in the 1st-person than in the 3rd-person perspective condition.

Further, we also compared the responses of these two groups on the difficulties in emotion regulation scale. Our secondary hypotheses were that (A) compared to non-smokers, daily smokers would self-report higher scores on the DERS, particularly on the lack of emotional clarity subscale, and (B) within daily smokers, lower reappraisal success would be associated with higher scores on the DERS, particularly on the lack of emotional clarity subscale.

2. Methods

2.1. Participants

This study employed a between-subjects design with 2 groups: 50 smokers and 50 non-smokers, all 18 – 63 years old. Participants were recruited from the Prolific Academic online recruitment pool (www.prolific.co) in exchange for financial payment (£7.50 per hour). Specifically, Prolific Academic has been developed as an open-access, online platform to enables large-scale data collection via the use of software such as Qualtrics (www.qualtrics.com.uk) or Inquisit (www.millisecond.com). Importantly, data collected from a range of tasks using Prolific Academic has been shown to be of a similar quality to data collected using Amazon's MTurk (www.mturk.com) (Palan and Schitter, 2018). All procedures were approved by the University of Roehampton Ethics Committee.

Inclusion/exclusion criteria were filtered through demographic and smoking-related questionnaires via the Prolific Academic system. Exclusion criteria included age < 18 or > 65 years old, self-report of any psychiatric disorder or drug dependence (other than tobacco use disorder for smokers), and lifetime illicit drug use; participants who endorsed the latter were excluded as such drug use may influence the ability to regulate one's emotions via the use of reappraisal (e.g., Fox et al., 2008). However, the use of alcohol and cannabis within the past year was permitted (and recorded) to ensure the sample was representative of the general population of smokers and non-smokers. Participants were classified as smokers if they endorsed smoking at least 5 cigarettes every day for at least one year, and as non-smokers if they endorsed smoking fewer than 10 cigarettes ever.

2.2. Questionnaire measures

Questionnaires were administered using Inquisit via Prolific Academic. Participants first completed a demographics questionnaire and a smoking history questionnaire (both developed in-house) to determine their smoking status and, if they endorsed smoking, their age of smoking initiation, the average number of cigarettes they smoke per day, the length of time they have been smoking this amount, the duration since their last cigarette and their will to quit. The average number of cigarettes smoked per day was used to determine nicotine/tobacco exposure, as was 'pack years' which was calculated as in previous research (e.g., Faulkner et al., 2020).

Participants were then asked whether they had consumed alcohol and/or cannabis in the previous 12 months, and if so, at what age they started such consumption and how many alcoholic drinks and/or joints they consumed in a typical week. Participants were also asked whether they had consumed cocaine, ecstasy or any other illicit drugs in their lifetime.

Smokers then completed the 6-item Fagerström Test for Nicotine Dependence (FTND; Fagerström, 2012) to quantify their level of nicotine dependence. Responses on this questionnaire have been associated with the behavioral and neural effects of smoking (e.g., Faulkner et al., 2017; Perez Diaz et al., 2021).

The 36-item Difficulties in Emotion Regulation Scale (DERS; Gratz and Roemer, 2004) was completed next. Scores on this questionnaire range from 1 ("almost never") to 5 ("almost always"). This questionnaire comprises of 6 subscales: lack of emotional awareness, lack of emotional clarity, limited access to emotion regulation strategies, nonacceptance of emotional responses, difficulty in engaging in goal-directed behaviors and difficulties in controlling impulses. All items are summed to create a total score, with higher scores reflecting greater difficulties in emotion regulation.

2.3. Emotion regulation task

This task was modified from that employed in Petersen et al. (2017), and began by presenting task instructions, including an explanation of how to use reappraisal to regulate negative emotions (instructions presented in the Supplementary materials). Participants completed 80 trials, each of which had three components: instruction (2 s), followed by image presentation (4 s) and the response interval (10 s) (*see* Fig. S1). Images were taken from the International Affective Picture System (IAPS; Lang et al., 2008), and participants were never shown the same image twice. Images presented to participants were those used in Petersen et al. (2017), and were classified as either 1st- or 3rd-person

perspective images (*see* Fig. 1 *for examples of each*). As such, there were three factors on this task, each of which had two levels; regulation condition (reappraisal vs react naturally), image valence (negative vs neutral) and image perspective (1st- vs 3rd-person perspective).

As such, across the 80 trials, there were eight trial types (10 trials per type): (1) ten 'reappraise, negative, 1st-person perspective' trials; (2) ten 'reappraise, neutral, 1st-person perspective' trials; (3) ten 'reappraise, negative, 3rd-person perspective' trials; (4) ten 'reappraise, neutral, 3rd-person perspective' trials; (5) ten 'react naturally, negative, 1st-person perspective' trials; (6) ten 'react naturally, neutral, 1st-person perspective' trials; (7) ten 'react naturally, negative, 3rd-person perspective' trials and (8) ten 'react naturally, neutral, 3rd-person perspective' trials. Trial order was randomized for each participant. After each image presentation, participants were asked 'How bad do you feel?' and responded using a Likert scale ranging from 0 ('not at all bad') to 6 ('very bad').

2.4. Data analyses

Statistical analyses were performed in the Statistical Package for Social Scientists (SPSS v25; IBM, Chicago, IL). The ability of all participants to use reappraisal was determined using a full-factorial ANOVA that contained mean responses to the question 'how bad do you feel?' as the dependent variable (DV), and regulation condition (reappraise vs. react naturally), image valence (negative vs. neutral), image perspective (1st- vs. 3rd-person) and group (smokers vs. non-smokers) as separate factors. Because we expected all four of these factors to concurrently influence mean responses, the term of primary interest of this omnibus ANOVA was the four-way interaction of these four factors.

To better understand this four-way interaction, two follow-up full-factorial ANOVAs were performed; one that contained only responses to 1st-person perspective images, and a second which contained only responses to the 3rd-person perspective images, each of which would examine the three-way interaction of (1) regulation condition, (2) image valence, and (3) group, and would determine whether there was a group difference in the ability to use reappraisal in response to viewing both image perspective types separately.

To better understand these three-way interactions, two final ANOVAs were performed. Specifically, both ANOVAs would contain group as a factor, while one of these ANOVAs would contain as the DV the difference between mean responses to negatively-valenced 1st-person images in the reappraise vs in the react-naturally condition ('reappraisal success' in the 1st-person perspective condition), while the other ANOVA would contain as the DV such difference scores from the 3rd-person perspective condition ('reappraisal success' in the 3rd-person perspective condition).

Fig. 1. Examples of images shown to participants that depicted scenes in which the viewer is the implied object (i.e. '1st-person perspective images'; left) and in which another person is the object (i.e. '3rd-person perspective images'; right).

The effect of smoking status on DERS scores was assessed using separate ANOVAs that contained group as a factor and relevant total or subscale DERS scores as the DV. Relationships between DERS total and subscale scores and 'reappraisal success' scores on the task in smokers were examined using bivariate correlations.

Because age and sex/gender can influence emotion regulation (Giromini et al., 2017; Zimmerman and Iwanski, 2014) and smoking behaviors (e.g., Faulkner et al., 2018), and because there was an effect of group on alcohol use (see below), these variables were added to all models to control for their influence on the DVs.

3. Results

3.1. Participant characteristics

Of the 100 participants who completed the study, 10 (9 smokers, 1 non-smoker) self-reported a diagnosis of depression; because this disorder is associated with heightened difficulties in emotion regulation these participants were excluded, leaving 49 non-smokers and 41 smokers in the final dataset (mean age = 28.88 years, SD = 10.22 years, range = 18–63 years). Participant characteristics are provided in Table 1. Because smokers and non-smokers differed significantly in age, sex/gender and alcohol use, all ANOVAs controlled for the effect of these variables on the dependent variable.

3.2. Reappraisal task

3.2.1. Whole group

We first examined whether participants as a whole were able to use reappraisal to regulate emotions induced by negatively-valenced images. This was done by examining the regulation condition-by-valence interaction from the omnibus ANOVA, which was significant ($F(1,85) = 8.509$, $p = 0.005$; Cohen's $f^2 = 0.489$, Cohen's f^2 95% confidence interval (CI) = 0.219–0.929; *see* Fig. 2). A follow-up ANOVA revealed that responses to *negative* images were lower in the 'reappraisal' condition than they were in the 'react naturally' condition ($F(1,85) = 5.766$, $p = 0.019$, Cohen's $d = 0.5369$, Cohen's d 95% CI = 0.239–0.833), whereas responses to *neutral* images did not differ between the reappraise' and 'react naturally' conditions; $F(1,85) = 0.369$, $p = 0.544$, Cohen's $d = -0.049$, Cohen's d 95% CI = −0.341 to 0.243).

3.2.2. Smokers vs non-smokers

We expected all four factors of regulation condition, image valence, image perspective and group to simultaneously influence the DV. As such, the main term of interest was the four-way interaction of (1) regulation condition, (2) image valence, (3) image perspective and (4) group on mean responses. The omnibus ANOVA revealed that this

Table 1
Participant Characteristics.

	Non-smokers	Smokers	Comparison
N	50	50	-
Gender (*M/F*)	25/24	30/11	$p = 0.032$*
Age (*years*)	26.14 (7.99)	32.15 (11.65)	$p = 0.005$*
Education (*years*)	15.71 (4.04)	16.49 (3.63)	$p = 0.346$
FTND Total	–	3.90 (2.02)	–
Cigarettes Per Day	–	14.29 (5.16)	–
Pack Years	–	4.89 (5.57)	–
Age Started Smoking (*years*)	–	17.22 (2.74)	–
Alcohol Use[a]	3.89 (4.48)	7.27 (6.44)	$p = 0.006$*
Cannabis Use[b]	1.37 (1.83)	2.27 (2.61)	$p = 0.295$

Values denote mean (SD)
[a] Denotes units of alcohol consumed per week.
[b] Denotes joints smoked per week.

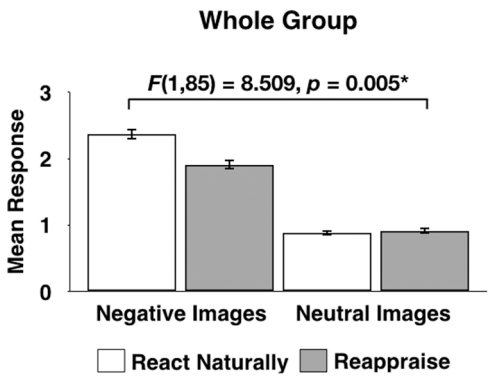

Fig. 2. Mean responses to negatively- and neutrally-valenced images in the 'reappraise' and 'react naturally' conditions, collapsed across image perspective type (i.e. 1st- vs 3rd-person perspective) and group (i.e. smokers and non-smokers). Asterisk denotes a significant regulation condition-by-image valence interaction, indicating that as a whole group, participants could successfully use reappraisal to self-regulate their emotions induced by negative images.

interaction was significant ($F(1,85) = 4.888$, $p = 0.030$; Cohen's $f^2 = 1.136$, Cohen's f^2 95% CI = 0.655–2.011).

To better understand this complex four-way interaction, we performed two follow-up ANOVAs; one that contained mean responses to only 1st-person perspective images and another that contained mean responses to only 3rd-person perspective images, to determine whether there was a significant three-way interaction between (1) regulation condition (2) image valence and (3) group on mean responses to 1st- and 3rd-person perspective images separately. Results revealed that the interaction on mean responses to 1st-person images was significant ($F(1,85) = 7.033$, $p = 0.009$; Cohen's $f^2 = 0.735$, Cohen's f^2 95% CI = 0.378–1.346), but that the interaction on responses to 3rd-person perspective images was not ($F(1,85) = 0.335$, $p = 0.564$; Cohen's $f^2 = 0.061$, Cohen's f^2 95% CI = −0.207 to 0.309).

Finally, to better understand the nature of the above significant 3-way interaction on 1st-person perspective images, we performed two final follow-up ANOVAs that contained (1) the difference between responses to negative, 1st-person perspective images in the reappraise vs in the react naturally condition (termed 'reappraisal success' in the 1st-person perspective condition) and (2) such scores from the 3rd-person perspective condition (termed 'reappraisal success' in the 3rd-person perspective condition). Results revealed that reappraisal success was significantly lower in smokers than in non-smokers in the 1st-person condition ($F(1,85) = 7.025$, $p = 0.010$, Cohen's $d = 0.756$, Cohen's d 95% CI = 0.326–1.185), but that there was no significant group effect on reappraisal success in the 3rd-person condition ($F(1,85) = 0.445$, $p = 0.507$, Cohen's $d = 0.151$, Cohen's d 95% CI = −0.264 to 0.566) (*see* Fig. 3). For mean responses to all image types in both groups, see Figs. S2 and S3.

The omnibus ANOVA revealed no significant interactions involving age, sex/gender or alcohol use, and bivariate correlations/independent t-tests revealed that these variables were not associated with 'reappraisal success' in either the 1st- or 3rd-person conditions (all $ps > 0.172$).

3.3. Difficulties in emotion regulation scale

There was no effect of group on DERS total or subscales scores (all $ps > 0.315$; *see* Table 2). For a full description of these results and the effects of age, sex/gender and alcohol use on DERS scores, see the Supplementary materials).

In smokers, DERS total and subscale scores did not correlate with 'reappraisal success' in either the 1st- or 3rd-person perspective conditions (all $ps > 0.212$). For exploratory correlational analyses to examine whether 'reappraisal success' is associated with responses on the DERS, see the Supplementary Materials.

3.4. Influence of smoking-related characteristics

FTND scores, the average number of cigarettes smoked per day, pack years and hours since last cigarette did not correlate with 'reappraisal success' in either the 1st-person or 3rd-person perspective conditions, or with any DERS scores (all $ps > 0.318$). However, a later age of smoking initiation was associated with greater reappraisal success in the 1st-person perspective condition ($r = 0.335$, $p = 0.032$, 95% CI = 0.029–0.640; *see* Fig. S4A) and with fewer difficulties in emotional clarity on the DERS ($r = -0.348$, $p = 0.026$, 95% CI = −0.044 to −0.651; *see* Fig. S4B). Age of smoking initiation did not correlate significantly with reappraisal success in the 3rd-person perspective condition, or with the DERS total

Table 2
Scores on the difficulties in emotion regulation scale (DERS).

Variable	Whole group	Smokers	Non-smokers
DERS Total	88.92 (28.12)	85.07 (24.84)	92.14 (30.47)
Lack of Emotional Awareness	14.92 (4.33)	15.39 (4.09)	14.53 (4.52)
Lack of Emotional Clarity	10.44 (4.09)	9.98 (3.93)	10.76 (4.24)
Difficulty in Controlling Impulsive Behaviors	13.10 (5.74)	12.80 (4.87)	13.35(6.41)
Difficulty in Engaging Goal-Directed Behaviors	15.90 (5.66)	14.71 (5.32)	16.90 (5.80)
Non-Accepting of Emotional Responses	14.52 (6.23)	13.85 (5.85)	15.08 (6.52)
Limited Access to Emotion Regulation Strategies	19.53 (7.72)	18.34 (6.76)	20.53 (8.39)

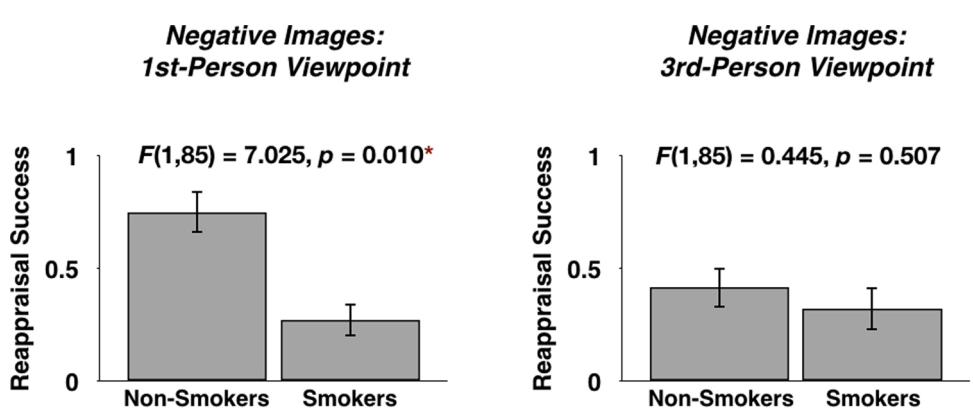

Fig. 3. Reappraisal success for non-smokers (blue) and smokers (red) when viewing negative images in the 1st-person perspective (left) and 3rd-person perspective (right). Asterisk denotes a significant group difference.

or other subscale scores (all $ps > 0.206$).

4. Discussion

Results indicate that smokers exhibit deficits in the use of cognitive reappraisal to downregulate negative emotions, especially when those emotions were induced by a negatively-valenced situation that was directed at themselves rather than to another person. Interestingly, smokers and non-smokers did not differ in terms of scores on the difficulties in emotion regulation scale. However, in smokers who exhibited the weakest ability to use reappraisal to self-regulate their emotions, there was an association between a greater lack of emotional clarity and lower reappraisal success. As such, one factor that could be hindering smokers' ability to use reappraisal could be an inability to understand the nature and/or valence of the emotion that they are trying to regulate.

The finding that daily cigarette smokers exhibit difficulties in the use of cognitive reappraisal may have implications for the development of smoking cessation interventions. Importantly, in the current study, 'reappraisal success' (i.e., the ability to use reappraisal to downregulate negative emotions), was lower for smokers than it was for non-smokers, as predicted. Indeed, the magnitude of this group effect on reappraisal success (Cohen's $d = 0.756$) was greater than that observed by Troy et al. (2010) (Cohen's $d = 0.566$) who compared the mean responses to negatively-valenced videos of non-smokers who used reappraisal vs non-smokers who were told to react naturally. Further, the magnitude of our observed group effect is slightly larger than that observed by Zimmermann et al. (2017) when they compared cannabis users vs non-users on a very similar reappraisal task as the one used in the current study (Cohen's $d = 0.650$). Importantly, the group effect reported in the current study was only observed when examining trials in which participants viewed images that presented a negatively-valenced scene in which the situation was directed towards the participant (i.e., '1st-person perspective' images). Indeed, 'reappraisal success' was roughly similar for both groups when examining trials in which participants viewed images of negatively-valenced situations that were directed towards somebody else/another object in the scene (i.e., '3rd-person perspective images). This is likely due, in part, to the fact that the negatively-valenced 3rd-person perspective images induced slightly lower responses to the question 'How bad do you feel?' than the negatively-valenced 1st-person perspective images in the whole group, indicating that there may have been less negative affect to regulate after viewing the former rather than the latter image type. Because it could be hypothesized that a situation is more likely to promote smoking behaviors if the negative outcome may happen/is happening to the smoker themselves rather than to another person, the development of emotion regulation techniques to aid smoking cessation may be improved by focussing on how to regulate more self-relevant negative emotions.

Our data indicate that this smoking-related deficit in the use of reappraisal was not related to smoking characteristics such as satiety (minutes since last smoked), lifetime nicotine/tobacco exposure (pack years or cigarettes smoked per day), or level of nicotine dependence (FTND scores). As such, it may be that the deficit in the use of reappraisal may be a smoking-related trait that does not change over time due to any of these smoking-related factors. Importantly, individuals with cocaine use disorder (Fox et al., 2007) and alcohol use disorder (Fox et al., 2008) exhibited reductions in scores on DERS subscales pertaining to a lack of emotional clarity and emotional awareness after 3–5 weeks of abstinence during inpatient treatment, although these studies did not indicate whether such reductions were associated with changes in cocaine/alcohol craving or use. As such, it may be possible to alleviate smoking-related deficits in reappraisal via training in the use of emotion regulation techniques, and future research may wish to test this hypothesis.

On the basis of previous literature, it was predicted that compared to non-smokers, daily smokers would self-report higher DERS total scores and higher scores on the lack of emotional clarity subscale. However, no such group difference was observed. This may partly be due to the fact that in the current sample, the non-smokers reported much higher scores on all DERS subscales (DERS total mean = 92.14, SD = 30.47) than the non-smokers in Faulkner et al. (2020) (DERS total mean = 59.95, SD = 15.15) and the non-drug users in Fox et al. (2007) (DERS total mean = 60.9, SD = 15.0), whereas the smokers in the current sample self-reported comparable scores to the smokers and cocaine users from those two studies. Two reasons may have contributed to this unexpected finding. Firstly, data from the current study was collected during the COVID19 pandemic, which has contributed to increases in anxiety and stress in many individuals Kwong et al. (2021), and may have influenced participants' ability to self-regulate their own emotions. Secondly, the current participants were tested via online methods, whereas the participants in Faulkner et al. (2020) and Fox et al. (2007) were recruited and tested in-person. It is currently unknown whether this difference in testing methods influenced the current findings, but one study recently reported that healthy individuals who volunteer for brain imaging studies self-report lower trait anxiety and negative affect than those who volunteer for psychology studies that do not involve brain imaging (Charpentier et al., 2021). Because many psychological studies now use online methods to recruit and test participants, future studies may wish to examine whether online sampling methods influence the characteristics of participants that are recruited.

This study has some limitations. Firstly, no objective measures such as expired carbon monoxide were collected to verify smoking status. Secondly, the cross-sectional design of this study limits our ability to determine any causal effects of smoking status on reappraisal abilities. Thirdly, while this study indicated that the perspective of the image (e.g. 1st-person vs 3rd-person) influenced smokers' difficulty in using reappraisal, we did not determine whether other aspects of the scene may have influenced responses. Finally, due to the fact that data was collected via online methods, it was not possible to determine the existence of symptoms of a mood disorder (which may likely influence emotion regulation abilities) via an in-depth clinical interview such as the Minnesota International Neuropsychiatric Interview (MINI: Sheehan et al., 1998). Future studies may therefore wish to collect such data when examining the association of smoking behaviors and emotion dysregulation.

In summary, this study provides the first evidence that daily smokers may be less able to use reappraisal to regulate emotions that are induced by self-salient negatively-valenced stimuli (i.e. scenes in which they themselves are the object). Further, results indicate that these smoking-related difficulties may be related to difficulties in understanding the nature and/or valence of the emotion being experienced. Future research is needed to achieve a complete understanding of smoking-related difficulties in emotion regulation, which would aid development of novel smoking cessation therapies to improve public health.

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Ethics approval and consent to participate

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

Contributors

Dr Paul Faulkner was involved in the study conception and design, data organization and analysis and manuscript preparation. Ms Sandra Machon was involved in study creation, data collection and organization and manuscript preparation. Dr Chris Brown was involved in study set-up and creation and manuscript preparation. Dr Marco Sandrini was involved in data interpretation and manuscript preparation. Professor Sunjeev Kamboj was involved in task design, interpretation of findings and manuscript preparation. Professor Paul Allen was involved in data interpretation and manuscript preparation.All authors have approved the final article.

Acknowledgments

Not applicable.

Conflicts of interest

The authors declare that they have no conflict of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2022.109416.

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