

The effect of exercise in reducing desire to smoke and cigarette withdrawal symptoms is not caused by distraction

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Abstract

Aims and design Moderate intensity exercise has been shown to reduce common smoking withdrawal symptoms and desire to smoke in acutely abstinent smokers. The aim of the present study was to determine if this was caused by distraction. A secondary aim was to determine whether exercise-related changes in affect were related to reduction in symptoms.

Methods Forty 'sedentary' participants who had smoked at least 10 or more cigarettes per day for at least three years were randomly assigned to one of two groups. They completed either 10 minutes of moderate intensity exercise on a stationary bicycle ergometer or 10 minutes of a cognitive distraction task (Paced Visual Serial Addition Task, PVSAT) after 11-15 hours of smoking abstinence. Participants rated smoking withdrawal symptoms and desire to smoke using standard scales at 10, 5 and 0 minutes before the experimental intervention, then at 5 and 10 minutes after the start of the intervention and 5 and 10 minutes after its completion.

Findings Significant Group x Time interactions were observed for ratings of desire to smoke and several withdrawal symptoms (irritability, depression, restlessness, difficulty concentrating and stress). There was a reduction in ratings during and immediately

following exercise that was not observed with cognitive distraction. Also it was found the effects were not mediated by changes in affect observed in the exercise condition.

Conclusions A brief bout of moderate intensity exercise can lead to a rapid reduction in desire to smoke and withdrawal discomfort, which is not due to the distracting effect of exercise or the effects of mood. These findings support recommendations to smokers to use exercise as a means of helping cope with the difficulties encountered when they try to stop.

KEYWORDS smoking cessation, exercise, distraction, withdrawal

INTRODUCTION

Evidence is accumulating that short bouts of moderate intensity exercise¹ reduces smoking withdrawal symptoms and the desire to smoke in sedentary smokers (Daniel *et al.* 2004; Taylor *et al.* 2005; Ussher *et al.* 2001). Ussher *et al.* (2001) examined the effects of 10-minutes of moderate intensity exercise on smoking withdrawal symptoms and desire to smoke cigarettes following overnight abstinence in adult sedentary smokers. Relative to a passive control group, cigarette cravings and withdrawal symptoms were significantly reduced in the exercisers whilst exercising, and the effect appeared to last up to 15 minutes post exercise. In a similar study, Daniel *et al.* (2004) examined the effect of five minutes of moderate intensity exercise and five minutes of light intensity exercise on tobacco withdrawal symptoms in a sample of sedentary smokers, and showed that moderate intensity exercise was associated with a short-term reduction in cigarette withdrawal symptoms and desire to smoke. Thus the positive effect of exercise on reducing smoking withdrawal symptoms and cigarette cravings has been widely demonstrated.

Unfortunately previous research has failed to determine the mechanisms underlying this phenomenon. One possibility is that by exercising, smokers are simply being distracted from their cravings (Bahrke & Morgan 1978; Morgan 1997). Morgan (1997) suggests that engaging in exercise creates a diversion from stressful thoughts and feelings and

¹ The term 'exercise' is used here to encompass both structured and lifestyle exercise, such as walking

induces lower levels of anxiety. It therefore remains a possibility that distraction may be the mechanism by which smoking withdrawal symptoms are reduced following exercise.

The main aim of the present study was to investigate whether distraction alone may influence smoking withdrawal symptoms and desire to smoke in sedentary smokers. To this end, individuals, following 11-15 hours of overnight smoking abstinence, were randomly assigned to either complete a 10 minute session of moderate intensity exercise on a stationary bicycle ergometer or 10 minutes of a cognitive distraction task (Paced Visual Serial Addition Task, PVSAT). The PVSAT requires individuals to monitor and add successive numbers and was specifically chosen for the present study as it limits the use of central executive functions to monitor mood (Diehr *et al.* 1998) and/or feelings of withdrawal and cigarette cravings. The rationale for using the PVSAT was to use a mentally distracting task but without the physical activity component of the ergometer. In line with previous research, measures of smoking withdrawal and desire to smoke were taken during, and before and after the exercise and distraction tasks.

The secondary aim of the present study was to determine whether exercise-related changes in affect were related to reduction in symptoms. An alternative explanation is that exercise-related changes in affect are related to reductions in smoking withdrawal symptoms. Many studies have pointed to the psychological benefits of exercise (Salmon 2001) and as such exercise-related mood effects may be related to reductions in smoking withdrawal and desire to smoke. In order to investigate this possibility, the present study,

in addition to assessing desire to smoke and smoking withdrawal symptoms, also included measures of positive affect (PA) and negative affect (NA) (Watson *et al.* 1988).

METHODS

Sample and procedure

Forty smokers ($n = 23$ male, 17 female) were recruited via advertisements placed around the University of Surrey campus. Participants were between 16 and 65 years of age, not receiving any form of psychiatric treatment, smoking at least 10 or more cigarettes a day for at least three years and reported to be sedentary. Being sedentary was defined as not engaging in vigorous exercise three or more times a week for at least 20 minutes each time, or doing some moderate intensity activity at least five times a week for 30 minute periods or more (Franklin, 2000). Full ethical approval for the study was granted via the University of Surrey Advisory Committee on Ethics.

Participants first completed eight questions of the physical activity readiness questionnaire (PAR-Q) to screen for exercise eligibility (Thomas *et al.* 1992). At this point participants' Carbon monoxide (CO) was measured using a Bedfont Smokerlyzer. A reading of 10ppm and above was used to verify that the participant was a regular smoker. Research has shown that after as little as 11-15 hours of abstinence from smoking, average resting heart rate (HR) drops an average 8.5 beats per minute in regular smokers (Perkins *et al.* 1989). As exercise intensity calculations are based on resting heart rate, smokers' heart rates were taken prior to abstinence, as this is more indicative of their normal resting heart rate. At testing the following day CO and resting heart rate

measurement was repeated. A reading of 10 ppm or less was taken as evidence of smoking abstinence. Next, respondents completed the Fagerström test for nicotine dependence (Heatherton *et al.* 1991), the seven-day physical activity recall questionnaire (Blair 1985), a stages of change for physical activity measure (Marcus *et al.* 1992) and two brief questions on desire and intention to quit smoking. At this point participants were fitted with a Polar heart rate monitor but they were unable to see the watch interface. During the procedure participants' heart rates were monitored. This allowed for continuous heart rate monitoring at five-second intervals. For the exercise condition a 'Cateye Ergociser' ergometer was used, the seat height was adjustable as was the physical load.

As a baseline measure participants completed the Mood and Physical symptoms scale (MPSS; West & Russell, 1985) and the Positive and Negative Affect Scale (PANAS) (Watson *et al.* 1988). The MPSS contained the following items: (1) Strength of desire to smoke, (2) irritability, (3) depression, (4) tension, (5) restlessness, (6) difficulty concentrating, and (7) stress. Each item was rated on a 7 point scale, ranging from 1 = not at all, 4 = somewhat, to 7 = extremely. In addition, a further item was used to assess tobacco withdrawal, 'I have a desire for a cigarette right now' (Tiffany & Drobes 1991), and was rated on a 7 point scale, ranging from 1 = strongly disagree, 4 = neutral, to 7 = strongly agree. The PANAS contains 10 positive adjectives (e.g., excited) and 10 negative adjectives (e.g., upset) describing feelings and emotions, which individuals rate on a 5-point scale. The scale ranges from, 1 (very slightly or not at all) to 5 (extremely). These orthogonal dimensions are scored independently by summing the total of positive

affect (PA) items and negative affect (NA) items. All scales were presented to participants via laminated cards. The MPSS and the PANAS were repeated at 5 & 10 minutes (therefore there were three baseline measures of withdrawal symptoms and affect). Social interaction between participants and experimenter was kept to a minimum. Participants were then randomly allocated to either of the following conditions (consisting of two intervention and two post-intervention measurement periods). Following completion of the study all participants were debriefed and paid the sum of £10.00 for their participation.

Moderate exercise

Participants were required to exercise for 10 minutes in their moderate intensity range (between 40-60% Heart rate reserve HRR) using the Karnoven method (Karnoven & Vuorimaa 1988). Each individual completed a warm up period lasting one to two minutes. At 4.5 minutes they rated their mood via the MPSS and PANAS but stopped pedalling for approximately 1 minute while completing the questions. Once all questions were completed, pedalling resumed, and the MPSS and PANAS were repeated at 10 minutes. Participants then dismounted from the exercise bike and sat down. At 15 minutes (5 minutes post exercise) participants completed the MPSS and PANAS again. They then sat quietly for a further 5 minutes (10 minutes post-exercise) and completed the MPSS and the PANAS a final time.

Cognitive distraction

A visual version of the Paced Audio Serial Addition Task (PASAT; Diehr *et al.* 1998) was used as the cognitive distracter. Each individual completed a one-minute practice session prior to starting the task. The PVSAT required participants to monitor the presentation of single digit numbers presented one per second, reporting out loud the sum of the last two numbers seen. The timing of the administration of the MPSS and PANAS mirrored those in the exercise condition. Participants were asked to do as well as they possibly could as their performance was being monitored.

RESULTS

The characteristics of the two groups are presented in Table 1. There were no significant differences between the two groups on these variables. Carbon monoxide at time 1 was significantly greater than CO at time 2 ($t(39) = 14.20, P < 0.001$) in both conditions. Resting HR pre-abstinence was significantly greater than resting HR during abstinence ($t(39) = 2.8, P < 0.01$) in all participants.

Ratings of MPSS were averaged across the three baseline readings, during the two intervention and two post-intervention phases of the study, and these data were analysed using analysis of covariance with the intervention and post-intervention ratings as the dependent variables, the moderate exercise and cognitive distraction conditions as between-subjects factors, and pre-intervention baseline ratings as covariates.

Insert TABLE 1 about here

Mood and physical symptoms

Mean ratings and the results of the ANCOVA for the eight mood and tobacco withdrawal symptoms are shown in Figure 1 (a-h).

Insert FIGURE 1 (a-h) about here

There were significant group main-effects for desire for a cigarette (Tiffany item), strength of desire to smoke and all withdrawal symptoms. Significant effects of time were found for tension, difficulty concentrating and stress only, and significant group by time interactions were found for desire for a cigarette (Tiffany item), strength of desire to smoke and all the withdrawal symptoms.

Repeated measures ANOVAs were conducted comparing ratings during and after interventions between conditions for each symptom and desire to smoke using baseline ratings as a covariate. Ratings during the exercise condition were significantly lower than ratings in the distraction condition for all symptoms and desire to smoke ($P < 0.01$). Ratings after the exercise condition were significantly lower compared to the distraction condition for desire for a cigarette ($P < 0.001$), irritability ($P < 0.01$), difficulty concentrating ($P < 0.01$), stress ($P < 0.01$) and strength of desire to smoke ($P < 0.001$). Ratings of depression ($P = 0.70$), tension ($P = 0.14$), restlessness ($P = 0.78$) were not significantly different between the exercise and distraction condition after interventions.

Within the exercise condition ratings during and after exercise were significantly lower for desire for a cigarette ($P < 0.001$), irritability ($P < 0.01$) and strength of desire to smoke ($P < 0.001$). Depression ratings ($P = 0.64$), tension ($P = 0.20$), restlessness ($P = 0.30$) difficulty concentrating ($P = 0.80$) and stress ($P = 0.83$) were not significantly different during and after exercise. Within the distraction condition ratings were significantly higher for irritability ($P < 0.001$), depression ($P < 0.01$), tension ($P < 0.001$), restlessness ($P < 0.05$), and stress ($P < 0.001$) during the condition compared to baseline ratings. No significant differences were found between ratings during and after the distraction condition for desire for a cigarette ($P = 0.26$), difficulty concentrating ($P = 0.80$), and strength of desire to smoke ($P = 0.41$).

In order to determine whether changes in affect during exercise are related to changes in symptom ratings, bivariate correlations were calculated between all the ratings of smoking withdrawal symptoms at all time points, and PA and NA. Due to the high number of correlations performed the alpha level was set at 0.01. No significant correlations were found between PA and NA and the desire to smoke a cigarette item of the MPSS (Tiffany item) or the strength of desire to smoke question in the exercise group (correlations ranging from $r = -0.31$ to $r = 0.37$). Significant correlations were found between negative affect and irritability, depression, tension, restlessness, difficulty concentrating and stress for both groups although this was not found for any item across every measurement point. These relationships were expected as items of the MPSS and affect, as measured by the PANAS, measure similar mood constructs e.g. tension and nervousness.

DISCUSSION

The main purpose of this study was to determine whether the reduction of smoking withdrawal symptoms and desire to smoke following moderate intensity exercise is caused by distraction rather than exercise *per se*. It was shown that during and immediately after exercise, common withdrawal symptoms and desire to smoke were rated lower, relative to baseline ratings. These results are consistent with previous research concerning exercise and smoking (Daniel *et al.* 2004; Taylor *et al.* 2005; Ussher *et al.* 2001). By contrast, cognitive distraction alone did not produce differences in common withdrawal symptoms or ratings of desire to smoke. The present results do not rule out however, the possibility that the effect of exercise on smoking withdrawal is partly the result of distraction.

The secondary aim of the study was to determine whether exercise-related changes in affect were related to reductions in withdrawal symptoms. No significant relationships were observed between PA, NA and desire for a cigarette and strength of desire to smoke at any time point. These are the most consistent and arguably important features of smoking withdrawal (West & Schneider 1988). Thus, the rapid reduction in desire to smoke and withdrawal discomfort, observed during acute moderate intensity exercise appears not to be due to the effects of mood changes.

There are at least two caveats of the study that warrant discussion. Firstly the majority of the participants were university students and therefore the sample consisted of individuals

who were generally younger, and possibly less chronically addicted to nicotine, compared to the majority of smokers in the UK. There is however, no obvious reason why the results would not generalise to the older adults or heavier smokers (Ussher *et al* 2000). Another limitation was that the distraction task may have actually been too demanding and engendered anxiety in some participants. The significant increase in difficulty concentrating seen during the task, for example, indicates this was likely and strength of desire to smoke was significantly higher during and after the distraction task. It would therefore be valuable for future investigations to utilise an equally distracting, but less stress provoking task than the one used in the present study, or to compare different distraction conditions. This may prove difficult due to the individual variability in perceptions of stress when completing such tasks.

In summary, the present findings suggest that cognitive distraction and changes in PA and NA during exercise are not the main mechanisms producing reductions in smoking withdrawal symptoms and desire to smoke in sedentary smokers.

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Table 1. Mean (SD) values for participant characteristics.

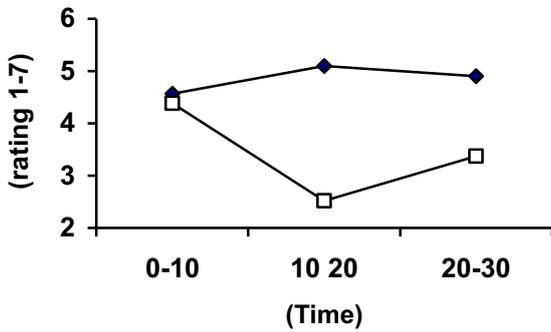
	Cognitive	Moderate	p-value
Age (years)	23.1 (4.1)	23.7 (3.5)	ns
Body Mass Index	25.2 (3.3)	25.9 (4.8)	ns
Years Smoked	6.45 (4.5)	6.25 (4.8)	ns
Cigarettes per day	14.2 (5.3)	13.7 (5.3)	ns
FTND	3.4 (1.6)	2.7 (1.7)	ns
ECO – time 1	16.6 (6.1)	17.3 (6.7)	ns
ECO –time 2	4.5 (2.3)	5.1 (2.9)	ns
Hours abstinence	13.6 (2.1)	13.6 (1.3)	ns
Motivation to quit	1.6 (1.1)	1.7 (1.3)	ns
Pre-abstinence RHR	76.8 (1.8)	75.3 (2.3)	ns
Post-abstinence RHR	72.8 (1.5)	71.9 (1.4)	ns

FTND = Fagerström Test for Nicotine Dependence, ECO = expired carbon monoxide,

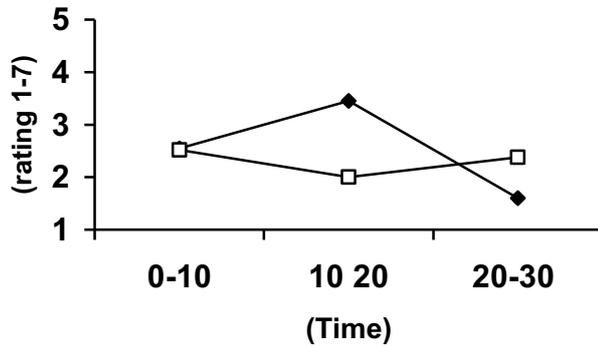
RHR = resting heart rate, ns = non significant

Figure 1 (a-h). Ratings of withdrawal symptoms and desire to smoke at each measurement time (high = 7, low = 1).

a) Desire to smoke



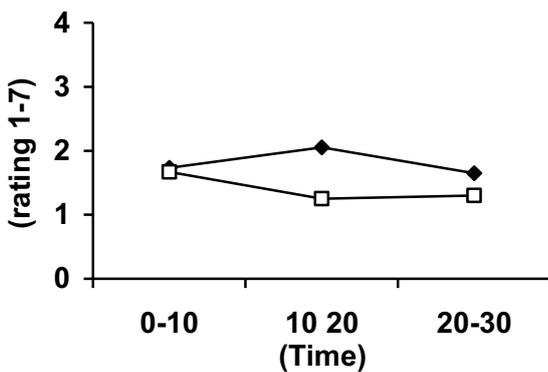
b) Irritability



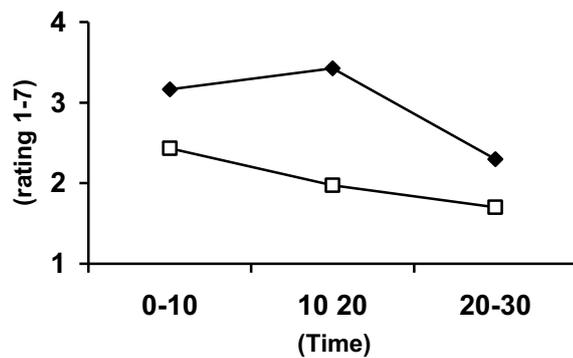
Group main effect ($F=17.86, p<.001$),
Time main effect ($F=3.60, p = .06$),
Group x Time interaction ($F=35.83, p<.001$).

Group main effect ($F=17.33, p<.001$),
Time main effect ($F=1.66, p = .20$),
Group x Time interaction ($F=7.08, p<.05$).

c) Depression



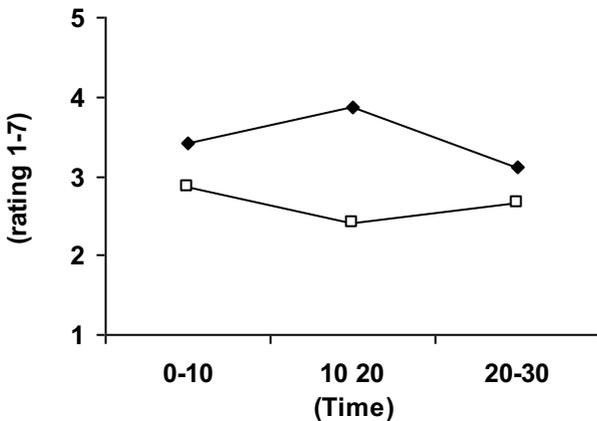
d) Tension



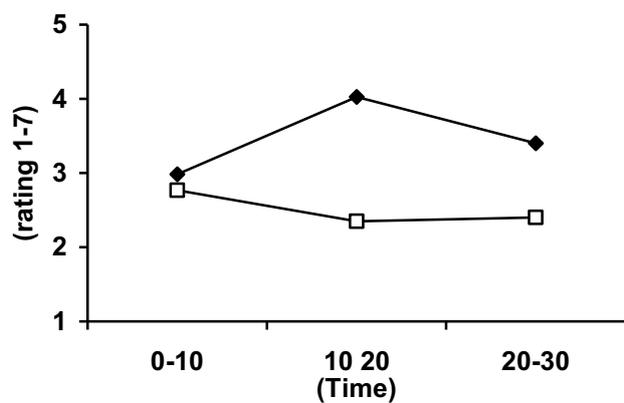
Group main effect ($F=12.32, p<.001$),
Time main effect ($F=.00, p = .98$),
Group x Time interaction ($F=6.90, p<.05$).

Group main effect ($F=14.79, p<.01$)
Time main effect ($F=10.09, p <.01$),
Group x Time interaction ($F=8.09, p<.01$).

e) Restlessness



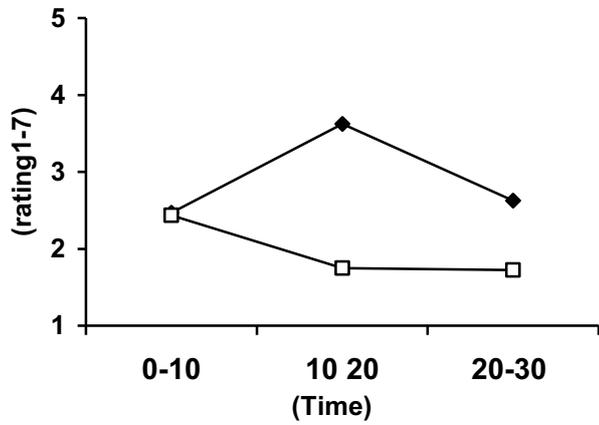
f) Difficulty concentrating



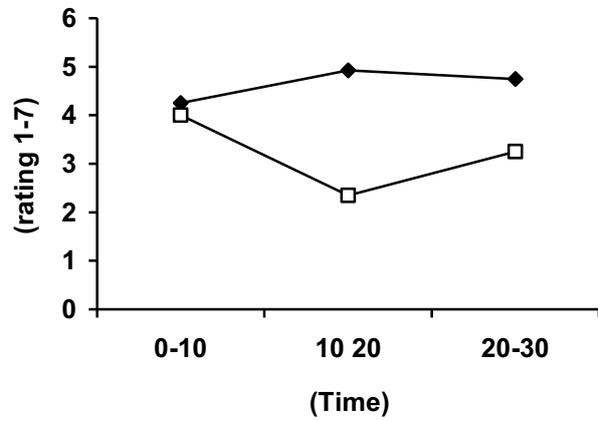
Group main effect ($F=4.44, p<.05$),
Time main effect ($F=.47, p = .49$),
Group x Time interaction ($F=7.64, p<.01$).

Group main effect ($F=21.53, p<.001$),
Time main effect ($F=4.39, p <.05$),
Group x Time interaction ($F=8.58, p<.01$).

g) Stress



h) Strength of desire to smoke



Group main effect ($F=30.98, p<.001$),
Time main effect ($F=4.18, p<.05$),
Group x Time interaction ($F=14.90, p<.001$).

Group main effect ($F=37.34, p<.001$),
Time main effect ($F=1.13, p = .29$),
Group x Time interaction ($F=17.83, p<.001$).

