HUMAN PSYCHOPHARMACOLOGY
Hum. Psychopharmacol. Clin. Exp. **13**, 367–376 (1998)

Comparative Mood States and Cognitive Skills of Cigarette Smokers, Deprived Smokers and Nonsmokers

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Regular cigarette smokers ($n = 15$), overnight deprived smokers ($n = 15$) and nonsmokers ($n = 20$), were assessed on a battery of mood questionnaires and cognitive performance tasks, before and after a cigarette/rest period. At the initial session, deprived smokers reported significantly greater feelings of stress, irritability, depression, poor concentration and low pleasure, than both nondeprived smokers and nonsmokers (all comparisons, $p < 0{\cdot}01$). After the rest/cigarette break, the mood states of all three groups became generally similar, although the previously deprived smokers still reported elevated depression. These findings suggest that mood gains after smoking reflect the simple reversal of abstinence effects. On the cognitive tasks, there were no significant differences in letter cancellation performance between subgroups, either before or after smoking. With mental arithmetic, abstinent and nonabstinent smokers attempted more problems than nonsmokers, both before and after the rest/cigarette break. This is suggestive of faster cognitive processing in smokers, irrespective of their nicotine status. However, the cognitive performance data were untypical in various ways and need replication. © 1998 John Wiley & Sons, Ltd.

KEY WORDS — nicotine; smoking; cigarette; abstinence; mood; cognition; performance

INTRODUCTION

In a review of the psychopharmacological effects of nicotine, West (1993, p. 590) noted: 'Although many smokers believe that cigarettes enhance their lives or at least they help them to cope with life's demands, there is as yet no clear scientific evidence to support this'. The essence of the problem is that although smokers often experience mood improvements and/or cognitive gains after smoking, abstinence generally leads to deleterious moods and/or cognitive impairments (Gilbert, 1995; Gilbert and Wesler, 1989; Hughes *et al.*, 1990, 1994; Parrott, 1994a,b, 1995a,b, 1998; Parrott and Roberts, 1991; Parrott *et al.*, 1996; Surgeon General, 1988, 1990; Wesnes and Warburton, 1983; West, 1993; Williams, 1980). It is therefore unclear whether the relative improvements post-smoking represent true psychobiological gains, or the simple reversal of abstinence effects. The nicotine resource model focuses upon the positive changes experienced during smoking, and suggests that nicotine leads to real psychological gains: 'It seems that cigarette smoking is a mood modifier for smokers, calming and reducing the smokers feelings of anxiety and anger' (Warburton, 1992, p. 57). In contrast, the deprivation-reversal model focuses upon the negative aspects of abstinence, and suggests that nicotine does not generate any real psychobiological advantages: 'Smoking doesn't make the smoker less irritable or vulnerable to annoyance, not smoking or insufficient nicotine makes him more irritable (Schachter, 1978, p. 210).

These two contrasting models are surprisingly difficult to resolve, since the natural/normal level of psychological functioning for each smoker is unknown (i.e. following years of nicotine use). One solution which has been advocated is to use nonsmokers as controls: 'Few studies include the important control group of nonsmokers not smoking to allow unequivocal determinations of whether smoking and nicotine are stress reducing, or whether abstinence and deprivation are stress increasing' (Surgeon General, 1988, p. 407). However, this procedure has been criticised, since smokers may differ from nonsmokers in important aspects (Hughes, 1991); nevertheless it is followed here, since no better alternative has emerged (see Discussion). The current study compared the

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CCC 0885–6222/98/050367–10$17·50

psychobiological functioning of deprived smokers, nondeprived smokers and nonsmokers. It was predicted that smokers would be superior to deprived smokers. However, the more crucial question was whether the active smokers would be superior to nonsmokers, or whether the deprived smokers would be worse than nonsmokers. The second aim was to compare the psychobiological effects of smoking a single cigarette, in deprived and nondeprived smokers. Smokers were only included if they smoked +10 cigarettes/day, and lit their first cigarette within an hour of waking. The aim was to study regular dependent smokers, and exclude light/social smokers (Wesnes and Warburton, 1983). Subjective feeling states were assessed using two questionnaires with demonstrated sensitivity to nicotine: the Addiction Research Unit smoking withdrawal scales (West *et al*., 1989), and the University of East London brief mood scales (Parrott *et al*., 1996). Cognitive skills were assessed on two performance tasks: letter cancellation, and mental arithmetic. Letter cancellation is generally impaired by smoking abstinence, and improved by cigarette smoking or other forms of nicotine administration (Parrott and Craig, 1992; Parrott and Roberts, 1991; Williams, 1980). Mental arithmetic was included as a more conceptual task, since higher cognitive skills have rarely been studied in smoking research (Garnham and Parrott, unpublished; Wesnes and Parrott, 1992).

METHODS

Subjects

The subjects comprised academic staff, postgraduate and undergraduate students from the University of East London. Cigarette smokers were included if they smoked +10 cigarettes/day, and lit their first cigarette within 1 h of waking. Thirty smokers were randomly allocated to either normal smoking or abstinence. The 15 smokers in the nondeprived (nonabstinent) condition comprised: 11 females and 4 males, mean age 23·9 years (range 19–31 years), smoking 17·4 cigarettes/day (range 10–27), having smoked for 8·5 years (range 5–14). The 15 smokers in the deprived (abstinent) condition comprised: 5 females and 10 males, aged 25·5 years (range 20–36), smoking 16·5 cigarettes/day (range 10–30), having smoked for 10·4 years (range 3–21). Nonsmokers were defined as those who had never smoked tobacco, or not smoked for at least one year. The 20 nonsmokers comprised: 13 females and 7 males, aged 29·5 years (range 18–48).

Smoking conditions

Nondeprived smokers arrived at the laboratory for their initial test having smoked normally that morning; they had been asked to smoke a cigarette 5–10 min before arrival. The overnight deprived smokers were required not to smoke for 12 h before testing. Compliance with these instructions was verbally checked on arrival, and biochemically confirmed by expired breath carbon monoxide (CO) assessment, with abstinence taken as a reading of <10 ppm CO (Hopkins *et al*., 1984). No subject failed these criteria. The initial period of performance and mood testing was followed by a 10 min rest break, when all smokers (deprived and nondeprived) smoked a single cigarette of their own brand, and nonsmokers rested for an equivalent period.

Assessment measures

The UEL mood questionnaire covered feelings of stress, arousal and pleasure (Parrott *et al*., 1996), reflecting the three primary feeling state dimensions (Mathews *et al*., 1990). Each mood factor was covered by two bipolar questions. Stress: tense/relaxed; nervous/calm. Arousal: lively/tired; alert/drowsy. Pleasure: contented/irritated; satisfied/dissatisfied. Responses were scored on five point bipolar scales. strongly–slightly–neither–slightly–strongly (0–4), so each mood factor comprised a nine-point scale.

The Addiction Research Unit (ARU) nicotine withdrawal questionnaire covered feelings of depression, irritability, energy, restlessness, hunger, poor concentration and the urge to smoke (West *et al*., 1989). The original 5-point response format (extremely–very–somewhat–slightly–not-at-all), was extended to nine points by the inclusion of four intermediate response positions, in order to make both mood questionnaires equivalent in the number of response alternatives.

Letter cancellation (Parrott and Craig, 1992; Parrott and Roberts, 1991), comprised a pencil-and-paper test of sustained visual attention. Subjects were required to scan rows of letters, and delete three target letters (e.g. T, G, U) with a penstroke. The total number of letters scanned in 10 min, and the proportion of targets correctly detected, were calculated. Twelve matched response sheets with different target letters were varied across test sessions, so that no sheet was seen more than once.

Mental arithmetic (Garnham and Parrott, unpublished; Parrott *et al.*, 1996), comprised a pencil-and-paper test of simple addition and subtraction. Each test sheet contained a standard set of 30 problems. Twelve test sheets were used, matched for difficulty level. Subjects completed as many problems as possible in 10 min, with response speed and accuracy both being scored.

Procedure

The study aims and requirements were described in a written instruction leaflet, and discussed with each subject beforehand. Each volunteer who wished to participate signed a written informed consent form, and was paid £10 on completion. Subjects were trained on the assessment battery during an hour-long massed practice session. This was held on an initial training day, when each task and questionnaire was demonstrated and explained. The mood scales were completed twice, while the cognitive tasks were undertaken four times (5 min per task each time). Additional 'filler' questionnaires were also completed, to provide breaks from the performance testing.

On the test day, subjects came to the laboratory at a pre-arranged time between 10.00 and 13.00 hours, and rested quietly for 5 min. Their smoking behaviour that morning was checked, then the first test battery commenced. Subjects were assessed in groups of 2–4 subjects. Each subgroup comprised either nonsmokers, deprived smokers or nondeprived smokers. They completed the two cognitive tasks, then the two mood scales. The order of test administration was held constant for each subgroup, but was counterbalanced across the different subgroups. The first period of testing was followed by the 10 min rest/cigarette break. During this period, subjects were required to remain quietly at their test consoles, but magazines were distributed for reading. Following this rest/cigarette period, the second (post-rest/cigarette) test battery was undertaken, with tests given in the same order as before. The subjects were then debriefed.

The data were analysed by split-plot ANOVA with two factors: subgroup (nonsmoker, smoker, deprived smoker), and test period (first, second). Duncan multiple comparison tests were performed between pairs of subgroups, at each test period.

RESULTS

The mood state data is shown in Figures 1 and 2, and Table 1; the cognitive performance results in Table 2. The ANOVA and Duncan multiple comparison tests are summarised in Table 3. The UEL stress scale showed significant group, period and group $\times$ period interaction effects (Table 3). At the first test period, feelings of stress were significantly higher in abstinent smokers, compared with both nonabstinent smokers ($p < 0{\cdot}01$), and nonsmokers ($p < 0{\cdot}01$); there were no stress differences between nondeprived smokers and nonsmokers (Figure 1, Tables 1 and 3). After the rest/smoking period, the stress levels of all three groups were similar (Figure 1). The UEL pleasure scale generated significant ANOVA period, and group $\times$ period interaction effects (Table 3). At the first test period,

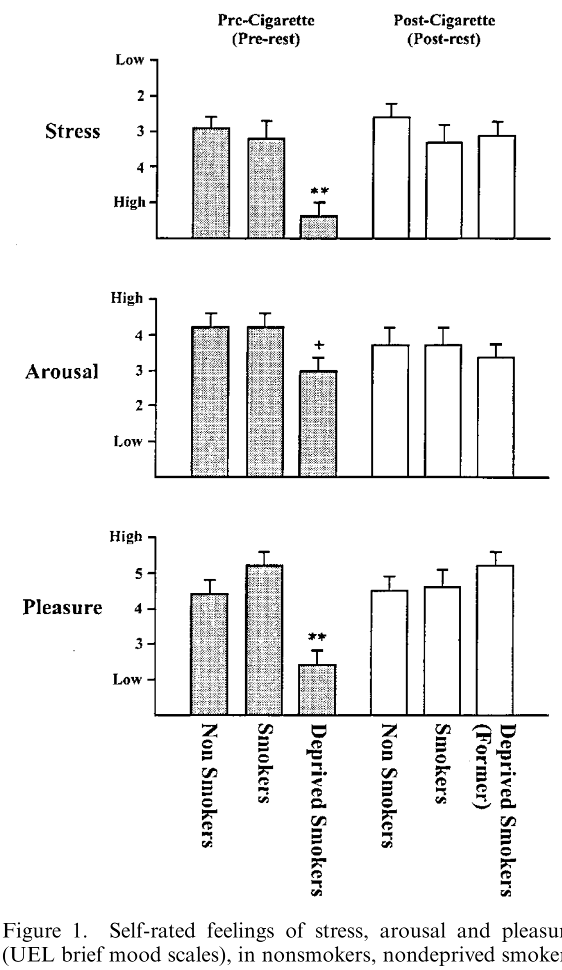

Figure 1. Self-rated feelings of stress, arousal and pleasure (UEL brief mood scales), in nonsmokers, nondeprived smokers and overnight deprived smokers, before and after a rest/cigarette break

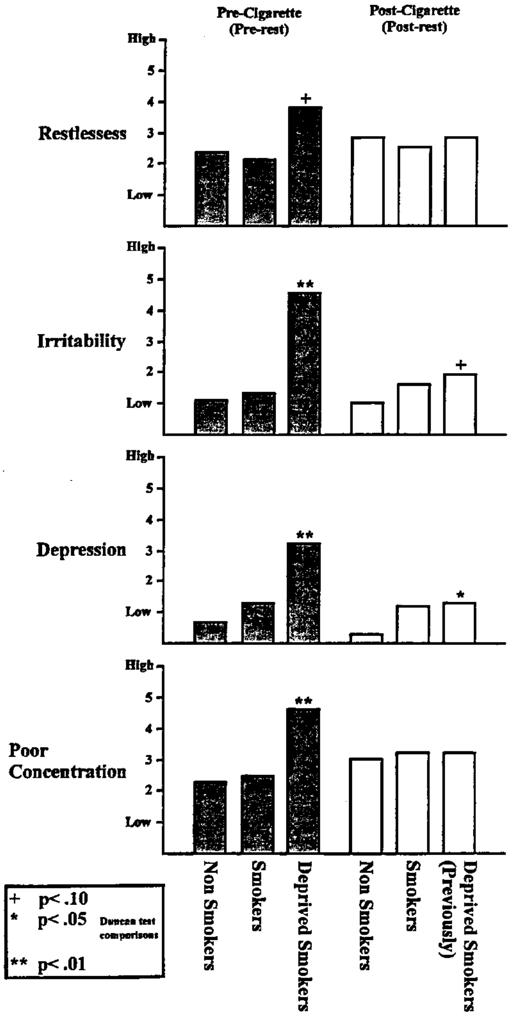

Figure 2. Self-rated feelings of restlessness, irritability, depression and poor concentration (ARU nicotine withdrawal questionnaire), in nonsmokers, nondeprived smokers and overnight deprived smokers, before and after a rest/cigarette break

feelings of pleasure were significantly lower in abstinent smokers than in both nonabstinent smokers ($p < 0{\cdot}01$) and nonsmokers ($p < 0{\cdot}01$). After the rest/smoking period, the pleasure scores of all three groups became similar (Figure 1, Tables 1 and 3). On the UEL arousal subscale, none of the ANOVA effects were significant, although there was a borderline trend for lower alertness in abstinent smokers at the first test period, in comparison with both other groups ($p < 0{\cdot}10$ for each comparison; Tables 1 and 3). Following smoking, the arousal scores for all three groups were again quite similar.

On the ARU mood scales, feelings of irritability showed significant ANOVA group, period and group $\times$ period interaction effects (Table 3). At the first test period, irritability was significantly greater in abstinent smokers than in both nonsmokers ($p < 0{\cdot}01$) and nonabstinent smokers ($p < 0{\cdot}01$; Table 3); there were no irritability differences between nondeprived smokers and nonsmokers. After the rest/cigarette period, feelings of irritability in the previously abstinent smokers became reduced, but were still somewhat elevated in comparison with nonsmokers ($p < 0{\cdot}10$; Figure 2, Table 3). The ARU depression scale demonstrated significant ANOVA group, period and group $\times$ period interaction effects (Table 3). At the first period, abstinent smokers were significantly more depressed than both nonabstinent smokers ($p < 0{\cdot}01$), and nonsmokers ($p < 0{\cdot}01$; Table 3). At the second test period, although feelings of depression became reduced in the previously abstinent smokers, they remained significantly elevated in comparison with nonsmokers ($p < 0{\cdot}05$). Furthermore, nonabstinent smokers also reported a borderline elevation in depression, compared with nonsmokers ($p < 0{\cdot}10$; Figure 2, Table 3). On the ARU restlessness scale, only the ANOVA group $\times$ period interaction effect was significant (Table 3). Abstinent smokers reported statistically borderline trends for higher restlessness ($p < 0{\cdot}10$) than both nonsmokers and nondeprived smokers (Figure 2, Tables 1 and 3). Feelings of poor concentration showed a significant ANOVA group $\times$ period interaction effect (Table 3). At the first test period, abstinent smokers reported worse concentration than both nonabstinent smokers ($p < 0{\cdot}01$) and nonsmokers ($p < 0{\cdot}01$). After the rest/cigarette break, the self-reported concentration abilities of all three groups again became similar (Figure 2).

Two ARU subscales showed no significant ANOVA or Duncan test findings: feelings of hunger and energeticness (Tables 1 and 3). However, the urge to smoke showed significant ANOVA group, period and group $\times$ period interaction effects (Table 3). At the first test period, abstinent smokers reported significantly stronger urges to smoke than both nonabstinent smokers ($p < 0{\cdot}01$) and nonsmokers ($p < 0{\cdot}01$), while the nonabstinent smokers also reported greater smoking urges that nonsmokers ($p < 0{\cdot}01$). After the rest/smoking period, the previously abstinent smokers still reported significantly greater smoking urges than both nonabstinent smokers ($p < 0{\cdot}01$) and

Table 1. Group mean (±standard deviation) mood self-ratings

		Nonsmokers	Smokers	Deprived smokers
UEL mood scales				
Stress	pre-cig	$2·9 \pm 1·3$	$3·2 \pm 1·9$	$5·4 \pm 1·6$
	post-cig	$2·6 \pm 1·9$	$3·3 \pm 1·9$	$3·1 \pm 1·6$
Arousal	pre-cig	$4·2 \pm 1·9$	$4·2 \pm 1·7$	$3·0 \pm 1·6$
	post-cig	$3·7 \pm 2·1$	$3·7 \pm 1·9$	$3·4 \pm 1·5$
Pleasure	pre-cig	$4·4 \pm 1·7$	$5·2 \pm 1·5$	$2·4 \pm 1·7$
	post-cig	$4·5 \pm 1·9$	$4·6 \pm 1·9$	$5·2 \pm 1·4$
ARU mood scales				
Restlessness	pre-cig	$2·3 \pm 2·3$	$2·1 \pm 1·7$	$3·8 \pm 2·9$
	post-cig	$2·8 \pm 2·2$	$2·5 \pm 1·6$	$2·8 \pm 1·9$
Feeling energetic	pre-cig	$3·6 \pm 2·2$	$2·9 \pm 1·8$	$2·4 \pm 2·1$
	post-cig	$3·3 \pm 2·2$	$2·6 \pm 1·9$	$3·1 \pm 1·6$
Irritability	pre-cig	$1·1 \pm 1·9$	$1·3 \pm 1·5$	$4·6 \pm 2·1$
	post-cig	$1·0 \pm 1·1$	$1·6 \pm 1·5$	$1·9 \pm 1·4$
Depression	pre-cig	$0·7 \pm 1·2$	$1·3 \pm 1·6$	$3·2 \pm 1·8$
	post-cig	$0·3 \pm 0·7$	$1·2 \pm 1·7$	$1·3 \pm 1·3$
Poor concentration	pre-cig	$2·3 \pm 1·6$	$2·5 \pm 1·6$	$4·7 \pm 2·3$
	post-cig	$3·0 \pm 1·9$	$3·2 \pm 1·5$	$3·2 \pm 1·7$
Hunger	pre-cig	$2·0 \pm 2·5$	$2·6 \pm 2·7$	$2·9 \pm 2·9$
	post-cig	$2·1 \pm 2·4$	$2·4 \pm 3·0$	$2·7 \pm 2·6$
Urge to smoke	pre-cig	$0·1 \pm 0·4$	$2·0 \pm 2·0$	$5·9 \pm 2·3$
	post-cig	$0·0 \pm 0·0$	$1·0 \pm 1·3$	$3·1 \pm 2·5$

Table 2. Group mean (±standard deviation) task performance scores

		Nonsmokers	Smokers	Deprived smokers
Letter cancellation				
Letters scanned	pre-cig	2460 ± 501	2324 ± 613	2319 ± 509
	post-cig	2194 ± 481	2024 ± 648	2113 ± 409
Proportion correct	pre-cig	$0·82 \pm 0·06$	$0·83 \pm 0·08$	$0·79 \pm 0·15$
	post-cig	$0·73 \pm 0·11$	$0·80 \pm 0·11$	$0·76 \pm 0·13$
Mental arithmetic				
Problems attempted	pre-cig	$72·5 \pm 23·5$	$91·0 \pm 20·8$	$89·5 \pm 26·9$
	post-cig	$81·6 \pm 27·2$	$98·1 \pm 20·5$	$96·5 \pm 25·0$
Proportion correct	pre-cig	$0·96 \pm 0·04$	$0·95 \pm 0·04$	$0·96 \pm 0·05$
	post-cig	$0·94 \pm 0·05$	$0·93 \pm 0·08$	$0·95 \pm 0·02$

Note: Pre-cig = pre-rest, and post-cig = post-rest, for the nonsmokers.

nonsmokers ($p < 0·01$; Tables 1 and 3) while again nonabstinent smokers reported greater urges than nonsmokers ($p < 0·01$).

On the letter cancellation task, there was a significant ANOVA period effect for the number of letters scanned, with less letters being scanned after the rest/cigarette period across all three groups ($p < 0·001$; Tables 2 and 3). Neither the ANOVA group effect, nor the group × period interaction were significant. Correct letter detections also showed a significant ANOVA period effect, with the proportion of correct target detections being reduced after the rest/cigarette break ($p < 0·001$; Tables 2 and 3). This post-rest reduction in target detections was proportionally greatest with the nonsmokers, so that there was a statistically borderline difference between nonabstinent smokers and nonsmokers at the second test period ($p < 0·10$; Table 3).

On the mental arithmetic task, there was a significant ANOVA period effect for the number of problems attempted, with a performance increase after the cigarette/rest break ($p < 0·001$; Table 3). The ANOVA group effect was borderline

Table 3. Summary of ANOVA findings and Duncan Multiple Comparison tests between subgroups

	ANOVA effects			Duncan Multiple Comparison tests					
				Pre-cigarette			Post-cigarette		
	Group	Period	G × P	NvS	NvD	SvD	NvS	NvD	SvD
UEL mood scales									
Stress	*	***	***		**	**			
Arousal					+	+			
Pleasure		**	***		**	**			
ARU scales									
Restlessness			*		+	+			
Feeling energetic									
Irritability	***	***	***		**	**		+	
Depression	***	***	***		**	**	+	*	
Poor concentration	+		**		**	**			
Hunger									
Urge to smoke	***	***	***	**	**	**	+	**	**
Cognitive performance									
LetterCan: total		***							
prop correct		***	+				+		
MentArith: total	+	***		*	*		+	+	
prop correct		+							

Two-tailed significance levels. Note: $p < 0.001$ levels not calculated for Duncan test. + $p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. N = nonsmokers; S = smokers; D = deprived smokers.

($p < 0.10$), while some Duncan test comparisons were also significant. During the first test period, nonsmokers attempted significantly less problems than both nondeprived smokers ($p < 0.05$) and deprived smokers ($p < 0.05$; Table 3), while after the rest/cigarette break, the number of problems attempted by the nonsmokers remained comparatively reduced, although the Duncan test comparisons with both groups of smokers were now statistically borderline (each comparison $p < 0.10$; Table 3). On mental arithmetic correct solutions, the ANOVA period effect was borderline in significance, with a lower proportion of correct answers after the rest/cigarette break ($p < 0.10$; Table 3).

DISCUSSION

Deprived smokers reported feeling significantly more stressed, more irritable, more depressed and less pleased than nondeprived smokers and nonsmokers (Figures 1 and 2). They also reported significantly poorer concentration, and borderline trends for lower arousal and greater restlessness than both of the other groups (Figures 1 and 2; Tables 1 and 3). In contrast, the moods of nondeprived smokers and nonsmokers were generally similar (Figures 1 and 2; Tables 1 and 3). The marked differences in mood state between deprived and nondeprived smokers agrees with the literature on the deleterious mood effects of abstinence. Numerous studies have reported increased feelings of stress, irritability, restlessness, depression and concentration difficulty during tobacco abstinence (Hughes, 1992; Hughes *et al.*, 1990, 1994; Parrott *et al.*, 1996; Shiffman and Jarvik, 1976; Surgeon General, 1988, 1990; West, 1993; West *et al.*, 1989). The present study also assessed nonsmokers as controls. The importance of this control group has been highlighted in various reviews (Hughes, 1991; Hughes *et al.*, 1990; Parrott, 1998; Surgeon General, 1988, 1990). Hughes *et al.* (1990, pp. 323–324) noted: 'If ... abstinent smokers are more anxious than smoking smokers and never-smokers, then the result can be attributed to abstinence effects. On the other hand, if abstinent smokers are more anxious than smoking smokers but equally anxious to never smokers, then the result may be due to the effect of smoking'. Various aspects of our data were in agreement with the deprivation reversal model: the similar moods of nonabstinent smokers and nonsmokers; the mood decrements in abstinent smokers; the mood normalisation when abstinent smokers were allowed to smoke

(Figures 1 and 2). These findings therefore agree with Schachter (1978, pp. 210–213): 'It would appear then that smoking is not anxiety reducing but, rather, that no smoking or insufficient nicotine is for the heavy smoker, anxiety increasing ... The heavy smoker smokes only to prevent withdrawal'. Silverstein (1982, p. 946) similarly noted that the calming effects of smoking, reflect the ending of withdrawal symptoms. However Schachter and Silvertein's conclusions were based upon stress ratings and pain perception. The wider range of mood states covered here demonstrates that the reversal of abstinence symptoms probably explains all the smoking-related mood changes (Parrott, 1998). Thus the 'calming' effects of cigarettes represent the reversal of the stress generated during abstinence. Similarly the 'pleasure' of smoking reflects reversal of the irritability engendered by abstinence (Figures 1 and 2).

An alternative explanation may, however, be offered for these findings, namely that smokers are predisposed to poor moods (Hughes, 1991; Warburton, 1988, 1992): 'This interpretation states that the differences between nonsmokers and abstinent smokers are due not to abstinence effects, but to a priori differences' (Hughes *et al.*, 1990, p. 324). Hughes (1991) noted that smokers and nonsmokers often differ in social class, educational achievement, genetic characteristics, personality profiles and numerous other parameters. Thus, in epidemiological terms there is a preponderance of smokers amongst the disadvantaged socio-economic groups. However, the subject pool in this study came from similar intellectual and socio-economic backgrounds, so that many of these potential confounding factors were controlled. However, the influence of personality differences between subgroups still remains; this is debated below, after the nicotine resource model is debated.

The resource model proposes that nicotine has genuine mood elevating properties, and leads to real stress reduction and a genuine boost in relaxation (Warburton, 1992). The main problem with this explanation is the absence of clear empirical mood data in its support. Thus when nicotine is given to drug naive subjects, the resource model predicts that mood gains should occur (e.g. just as with an acute dose of a benzodiazeine). But, instead, the empirical evidence shows that when nonsmokers are administered an acute dose of nicotine they report a range of negative moods (Foulds *et al.*, 1997; Newhouse *et al.*, 1990). Moreover, in theoretical terms, there is no clear rationale for predicting anxiety reduction in a cholinergic agonist. The main evidence for the resource model is indirect; namely that smokers tend to report slightly higher neuroticism scores than nonsmokers (Gilbert, 1995, p. 152). The study most widely quoted as providing empirical evidence for nicotine resource model is the mixed longitudinal and cross-sectional study by Cherry and Kiernan (1978). They found that extraversion and neuroticism scores at age 16 were associated with the likelihood of being a heavy smoker at age 25. However, there are limitations to their data, most importantly, that many of their subjects were already smoking at age 16, and since smoking may contribute to stress (Parrott, 1995b), their slightly higher neuroticism scores may reflect this. Other longitudinal studies have failed to find a predictive relationship between neuroticism scores in childhood and adult smoking behaviour (see West 1994). Another problem is that the neuroticism differences between smokers and nonsmokers reported by Cherry and Kiernan (1978) were less than one point on the Maudsley Neuroticism Scale, and this small difference cannot explain the markedly poor moods experienced by deprived smokers here (Figures 1 and 2). There are other problems with the nicotine resource model. Thus our nonabstinent smokers failed to report any mood gains after smoking (Figures 1 and 2), while in a similar fashion, the degree of liking for a cigarette is a direct function of the duration of nicotine abstinence (Fant *et al.*, 1995). It is also difficult to explain 'craving' if nicotine is just a resource. However, the strongest evidence against this model comes from smoking cessation studies.

If nicotine is a genuine mood resource, then smokers should suffer from adverse moods when they quit (Parrott, 1995b). However, while smokers do report negative moods for several weeks post-quitting, the long-term mood effects of cessation are generally beneficial. There are no cessation studies which demonstrate long-term mood decrements after quitting. Instead, several studies have documented mood improvements. Cohen and Liechtenstein (1990) assessed the moods of smokers planning to quit smoking, both at (smoking) baseline, and over the ensuing six months. Successful quitters reported a steady decrease in stress over the six month period. In contrast, those who failed to quit reported high levels of daily stress over the same period. Crucially, the stress levels of successful and unsuccessful quitters were identical at baseline, thus it was not just the 'low stress' individuals who managed to quit. Two other longitudinal studies have confirmed that quitting smoking leads to reduced feelings of stress (Carey *et al.*, 1993; Parrott, 1995b). Furthermore, cessation also leads to a reduction in depression, restlessness and irritability (Hughes, 1992; Hughes *et al.*, 1994). These findings are completely opposite to those predicted by the nicotine resource model. (Note: the resource model could argue that if some smokers do develop enduring mood decrements when they quit, they will also tend to relapse. Thus any group of long-term abstainers will be under-represented by those who genuinely suffer without nicotine. This needs to be empirically investigated).

In the present study, two ARU mood scales failed to demonstrate any significant ANOVA effects: feelings of hunger and energeticness (Table 3). These two measures were also the only scales to show no significant drug effects in a previous 24-h tobacco abstinence study (Parrott *et al.*, 1996). The null findings with the ARU energeticness scale may be a reflection of its wording; perhaps 'alertness' might be more sensitive to nicotine/abstinence than 'energeticness'. With reference to hunger, while most studies have found increased ratings of hunger during cessation, their time course seems to be gradual in onset, yet persistent over time (Hughes *et al.*, 1990, 1994; Surgeon General, 1988, 1990; West *et al.*, 1989). It may therefore be that the changes in appetite under nicotine/abstinence are psycho-biologically distinct from the changes in mood.

Turning to the cognitive findings, both tasks showed significant ANOVA period effects, with marked performance changes after the rest/cigarette break. With letter cancellation, less stimuli were scanned ($p < 0{\cdot}001$), while correct detections were reduced ($p < 0{\cdot}001$; Tables 2 and 3); thus both aspects of task performance deteriorated after the rest/cigarette break. With mental arithmetic, more problems were attempted ($p < 0{\cdot}001$), but the proportion of correct solutions was reduced ($p < 0{\cdot}10$; Table 3); thus mental calculations became faster but somewhat less accurate after the rest/cigarette break. These performance changes occurred in *all* three subgroups, and may reflect the general effects of fatigue and repetition. During the debriefing, several subjects complained that the letter cancellation task was very repetitive and boring. Letter cancellation performance was generally similar across subgroups (Tables 2 and 3). The similar performance levels for the abstinent and nonabstinent smokers contrasts with previous findings, since active smokers generally display better sustained attention than deprived smokers (Hughes *et al.*, 1990; Parrott and Craig, 1992; Parrott and Roberts, 1991; Revell, 1988; Wesnes and Warburton, 1983; Williams, 1980). The absence of any performance gains post-smoking is also unlike previous findings, where performance gains generally occur with the first cigarette following abstinence (Parrott and Roberts, 1991; Parrott and Winder, 1989; Revell, 1988; Williams, 1980). On the mental arithmetic task, deprived and nondeprived smokers generated similar performance levels, both before and after the cigarette break. These findings were again untypical, since previous studies have generally shown cognitive impairments in deprived smokers compared to non-deprived smokers, and performance improvements when abstinent smokers are allowed to smoke (Garnham and Parrott, unpublished; Snyder *et al.*, 1989; reviews by Hughes *et al.*, 1990; Wesnes and Parrott, 1992). In the current study, nonsmokers attempted less problems than nondeprived smokers and deprived smokers at both testing periods (Tables 2 and 3). These findings are indicative of faster cognitive processing in smokers, irrespective of their nicotine status (deprived or nondeprived). But again this is untypical of most previous research. No previous studies have shown nicotine deprived smokers to be superior to nonsmokers, whereas many trials have found them to be comparatively impaired (reviews by Sherwood, 1993; Wesnes and Parrott, 1992; also Keenan *et al.*, 1989).

Overall, therefore, the cognitive profiles were atypical in several ways: the similar performance by deprived and nondeprived smokers; the absence of any cognitive gains when deprived smokers smoked; the slower mental arithmetic performance of nonsmokers (Tables 2 and 3). Various factors may have contributed to these unusual findings. Firstly, the parallel groups design, with subjects not acting as their own controls. Secondly, the intensity of the initial training, with subjects undergoing massed practice on a single day. (Note: our previous trials have used spaced practice sessions, with three different training days, e.g. Parrott and Craig, 1992). Thirdly, the volume and repetitiveness of the testing regimen. On the training day, subjects performed each cognitive task four times in one hour, while on the test day, extended periods of testing were again involved. This may have led to fatigue or boredom, possibly masking the more subtle cognitive effects of nicotine. The current cognitive test findings therefore need replication, with subjects tested on a less intensive programme, and trained using spaced practice sessions.

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