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Cigarette Smoking and Abstinence: Comparative Effects Upon Cognitive Task Performance and Mood State over 24 Hours

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Twenty regular smokers were assessed over 24-h of normal cigarette smoking, and an equivalent period of abstinence. In both conditions, a non-deprived baseline was followed by performance tests 2, 6 and 24 h later, while subjective feelings were assessed every 2 h. Compared to normal smoking, abstinence led to reduced heart rate, worse task performance, feelings of depression, stress, irritability, restlessness, poor concentration, and urges to smoke. Letter cancellation and number vigilance task performance were significantly poorer after 2 and 6 h of abstinence. Subjective feeling states were significantly worse after 4 h of abstinence, and became increasingly impaired over the rest of the day. However many abstinence symptoms (except heart rate), were reduced in severity at the 24-h session, held on the morning of the following day. This suggests that many of the psychological effects of smoking abstinence, may build-up afresh each day.

KEY WORDS — nicotine; tobacco; smoking; abstinence; withdrawal; mood; stress; irritability; performance; cognition; attention

INTRODUCTION

When regular smokers abstain from smoking, they typically report a range of subjective abstinence symptoms: irritability, poor concentration, restlessness, hunger, and cigarette craving (Shiffman and Jarvik, 1976; Stitzer and Gross, 1988; West and Russell, 1988; West *et al.*, 1989; Hughes *et al.*, 1990). The consistency of findings across studies, shows that the range of smoking withdrawal symptoms is well documented (West *et al.*, 1989). However, most of these studies have measured withdrawal symptoms at only one or two time points, allowing West *et al.* (1989, p. 143) to conclude: 'There is little data on the time course of nicotine withdrawal symptoms'. More recently, Hughes (1992) measured withdrawal symptoms between 2 to 180 days post-cessation. The most severe abstinence symptoms were reported at the initial 2-day session, which raises the question of when they first develop during this initial period of abstinence. This is the central aim of the present study.

Similar questions can be raised with respect to objective task performance. Many studies have found higher levels of task performance in active smokers, compared to deprived smokers (Williams, 1980; Wesnes and Warburton, 1983; Hasenfrantz *et al.*, 1989; Parrott and Roberts, 1991). Performance improvements in deprived smokers, have been empirically demonstrated after just one or two inhalations (Revell, 1988). In contrast, there is little information on the time course of performance changes during nicotine depletion. Foulds (1994) noted: 'I am not aware of a single placebo-controlled study looking at the time-course of cognitive performance changes following nicotine abstinence'. The other aim of the present study was therefore to measure cognitive task performance, over 24 h of smoking abstinence. However 24 h generally covers both sleep and waking, and the present study only sampled mood and performance during waking (it comprised a diurnal rather than circadian study (Folkard, 1983). Moods were assessed at baseline (around 10 am), then every 2 h until 12 h post-baseline (late evening), then finally again after 24 h (the following morning). Cognitive task performance was assessed at four test sessions: baseline, 2 h post-baseline (late morning), 6 h post-baseline

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(late afternoon), then after 24 h (following morning). The parallel use of subjective and objective measures, also allowed their time courses to be directly compared.

METHOD

Subjects

Twenty regular cigarette smokers (10 male, 10 female) agreed to participate in the study. The aims and objectives of the investigation and all subject requirements, were fully explained beforehand, while subjects were paid £20 on successful completion. Criteria for inclusion were: consumption of +10 cigarettes/day for at least 1 year (+18·6 ± 8·6 cigarettes/day), and +18 years of age (22·9 ± 5·5 years).

Smoking and abstinence conditions

In the smoking condition, subjects condition were asked to smoke normally. In the deprivation condition, subjects were required to abstain from smoking for 24 h. In both conditions, subjects were asked to smoke one cigarette during the 15 min before the first test session, in order to make certain that they are *not* deprived at baseline. The later test sessions followed 2, 6, and 24 h of abstinence, or normal smoking. In the smoking condition, subjects were requested to smoke before coming in for each test session. In the abstinence condition, non-smoking compliance was randomly checked by asking subjects to confirm that they had not smoked, and giving carbon monoxide expired breath tests. None of the subjects in the abstinence condition failed the CO test, a criterion of less than 10 parts CO per million being required (West *et al.*, 1989).

Assessment measures

Four objective performance tasks, and two subjective feeling state questionnaires were used.

Letter cancellation. (Williams, 1980; Parrott and Roberts, 1991; Parrott and Craig, 1992). This comprises a pencil-and-paper test of sustained visual attention. Subjects were required to scan rows of letters, and delete each instance of three target letters (e.g. TGU) with a penstroke. Time for completing the response sheet of 1350 letters, and total targets detected (maximum = 105), were each recorded. Twelve matched response sheets were varied across sessions.

Number vigilance. This computerized test of sustained attention, comes from the Cognitive Drug Research test battery (Wesnes *et al.*, 1988; Van Harten *et al.*, 1992). A randomly selected target number (0–9) was displayed on the right of a 34-cm colour monitor, while a rapid succession of number stimuli appeared in the screen centre (150 numbers/min). Subjects were required to press the YES button on a peripheral response box, each time a stimulus number matched the target. The series of numbers was balanced, with five targets for every 50 numbers, while no number appeared twice in succession. The 3-min test period generated 45 targets. Correct responses were recorded to the nearest ms, and were defined as those occurring between 150–1000 ms after a target. If a response was not produced within this period, this counted as a miss; all other responses comprised false alarms.

Simple reaction time (Wesnes et al., *1988; van Harten* et al., *1992).* Subjects were required to press the YES response key, whenever the word YES appeared on the monitor screen. Fifty stimuli were presented with a random inter-stimulus between 1 and 3·5 s. Statistical outliers were excluded from the calculation of average response times, while the number of outliers was also recorded.

Choice reaction time (Wesnes et al., *1988; van Harten* et al., *1992).* Subjects pressed the YES response button to a YES stimulus on the VDU screen, and the NO button to a NO stimulus. Fifty trials of each stimulus word were presented in a random sequence, with a random inter-stimulus interval between 1 and 3·5 s. Incorrect responses were recorded; but they (and any statistical outliers), were automatically excluded from the calculation of the mean response time.

Self-rated feelings of stress, arousal, and pleasure. These were measured on the UEL smoking/mood questionnaire (Parrott, 1994, 1995a; Parrott and Garnham, unpublished). These moods reflect three primary feeling state dimensions (Matthew *et al.*, 1990). Each mood factor was covered by two bipolar questions: stress, tense/relaxed and nervous/calm; arousal, lively/tired and alert/drowsy; pleasure, contented/irritated and satisfied/

dissatisfied. Responses were scored on a 5-point bipolar scale: strongly–slightly–neither–slightly–strongly. Each question generated a response between 0–4, while the overall 9-point score ranged from 0–8.

The Addiction Research Unit (ARU) nicotine withdrawal questionnaire (West et al., *1989).* This covered feelings of depression, irritability, energy, restlessness, hunger, poor concentration, and urge to smoke. The original 5-point response format (extremely – very – somewhat – slightly – not-at-all), was extended to 9 points, by the inclusion of four intermediate response positions. The aim of this procedure was to make the ARU and UEL mood scales equivalent in the number of response choices.

Heart rate. This was recorded using a Tunturi meter attached to the ear lobe (Parrott and Winder, 1989). Resting heart rate was recorded at three predetermined time points prior to testing. Testing heart rate was similarly recorded at three points during the performance test cycle. Overall means were scored.

Experimental design

Each subject was tested under both conditions, with the test order counterbalanced (smoking/deprived; deprived/smoking). The baseline test session commenced at around 10 am (range 9–11 am) while later sessions were held after 2 h, 6 h, and 24 h (the next morning). No restrictions on everyday activities were made, although each subject was tested on a weekday when they were already coming to the University. Each subject acted as their own control, so the two test days should have been similar in terms of general patterns of occupational activity. Testing was in an individual cubicle, with the experimenter also present. Subjects were fully trained on the performance tasks beforehand. This comprised an initial familiarization session, followed by three spaced practice sessions. The subjective feeling states were completed at 2-h intervals throughout the day, at 0, 2, 4, 6, 8, 10, 12 and 24 h.

Data analysis

The data were analyzed by split-plot ANOVA with three factors: drug (smoking, deprived), time (0–24 h), and order of testing (smoking/deprived, deprived/smoking). The SPSS-pc package was also used to calculate drug effects within each time period.

RESULTS

Group mean values are shown in Tables 1 and 2, while the ANOVA findings are summarized in Table 3. Selected measures are also presented graphically: letter cancellation (Figure 1), number vigilance (Figure 2), and several subjective feeling states (Figure 3). The characteristics of these regular smokers were broadly similar to those in other studies (West and Russell, 1985; Parrott, 1994), with Smoking Motivation Questionnaire profiles as follows: psychological image $0{\cdot}4 \pm 0{\cdot}7$; hand/mouth activity $4{\cdot}5 \pm 3{\cdot}3$; indulgent $6{\cdot}0 \pm 3{\cdot}2$ sedative $6{\cdot}7 \pm 2{\cdot}7$; stimulant $4{\cdot}9 \pm 3{\cdot}8$; addictive $10{\cdot}3 \pm 4{\cdot}0$, and automatic $1{\cdot}5 \pm 1{\cdot}9$.

Letter cancellation target detection was significantly affected by drug ($P < 0{\cdot}01$), and drug × time interaction ($P < 0{\cdot}001$; Table 3). Baseline detection rates were similar for both conditions,

Table 1. Group means for the task performance and physiological measures

	Normal smoking				Smoking abstinence			
	Baseline	2 h	6 h	24 h	Baseline	2 h	6 h	24 h
Heart rate resting (bpm)	79·9	79·5	80·9	78·8	85·7	75·7	72·2	69·1
Heart rate testing (bpm)	86·4	87·7	84·5	87·6	91·0	84·0	81·6	76·4
Letter cancellation total hits	87·7	88·7	89·6	90·8	88·1	84·6	80·0	81·8
Letter cancellation resp. time (s)	357	338	352	386	370	369	411	400
Digit vigilance percentage hits	96·4	98·0	98·5	97·2	97·6	95·9	96·3	96·7
Digit vigilance response time (ms)	414	404	406	419	410	422	423	412
Digit vigilance false alarms	0·6	0·5	0·3	0·5	0·5	0·3	0·4	0·4
Simple reaction time (ms)	257	255	257	260	259	263	275	259
Choice reaction time (ms)	416	404	404	414	422	418	423	429
Choice reaction time % accuracy	98·1	97·9	96·9	97·4	97·6	97·4	97·9	96·8

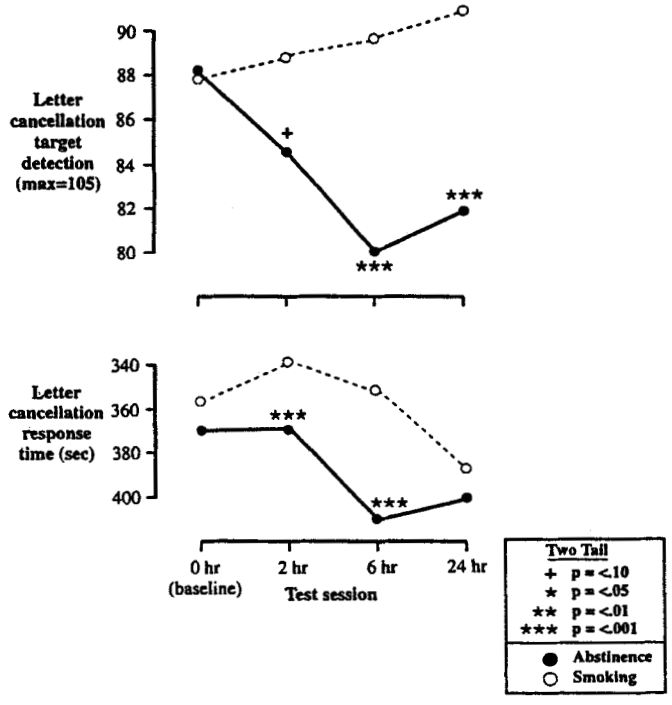

Figure 1. Letter cancellation task performance under cigarette smoking and abstinence

but became comparatively impaired under abstinence. Significantly lower target detection rates were evident after 2, 6, and 24 h of smoking deprivation (Figure 1, Tables 1, 3). Letter cancellation response times showed a similar pattern, with significant ANOVA drug ($P < 0{\cdot}01$), ($p < 0.001$), and drug × time ($P < 0{\cdot}05$) effects (Table 3). Compared to normal smoking, response times were comparatively longer under abstinence, with significantly poorer performance at the 2- and 6-h sessions, although not after 24 h (Figure 1).

On the number vigilance task, similar performance trends were generally evident, with higher rates of target detection and faster responses under smoking than abstinence (Figure 2). The ANOVA

Table 2. Group means for the self-rating questionnaires

	Normal smoking								Smoking abstinence							
	Baseline	2 h	4 h	6 h	8 h	10 h	12 h	24 h	Baseline	2 h	4 h	6 h	8 h	10 h	12 h	24 h
ARU scales																
Depression	0·5	0·9	0·5	0·5	0·7	0·8	0·9	0·5	1·1	1·1	1·3	1·7	2·2	2·5	2·1	1·4
Irritability	0·8	1·3	1·1	1·2	1·0	1·6	1·6	1·2	1·2	1·5	2·2	3·4	3·0	3·9	3·7	2·8
Energy	2·4	2·4	2·2	2·1	2·4	2·2	1·5	2·3	2·1	2·2	2·1	2·1	2·3	2·2	1·7	2·3
Restlessness	1·7	1·9	1·9	1·8	1·6	1·7	1·5	1·5	1·5	2·3	2·8	3·4	3·6	3·7	3·0	2·7
Hunger	2·1	3·0	2·4	1·9	1·7	1·9	1·8	2·3	2·4	2·9	2·4	2·7	3·5	2·9	2·5	3·1
Poor concentration	2·2	2·3	2·3	2·5	2·1	2·1	2·9	2·4	2·7	3·0	3·3	4·7	4·4	3·9	4·0	3·7
Urge to smoke	2·7	2·6	2·5	2·7	3·5	3·5	3·3	3·0	3·3	3·2	4·7	5·4	5·7	5·9	5·6	5·2
UEL scales																
Stress	2·5	3·0	2·8	3·0	3·1	2·9	2·6	3·4	3·9	3·6	3·7	3·8	4·2	4·7	3·9	3·7
Arousal	3·1	4·0	3·9	3·4	4·2	3·4	2·3	3·0	3·0	3·2	2·7	3·2	3·0	3·0	3·0	2·9
Pleasure	4·7	4·0	4·4	4·2	4·3	4·5	4·2	4·4	3·8	3·6	3·2	2·6	2·6	2·3	2·4	3·5

Table 3. Summary of ANOVA findings

	Main effects			Interactions				Drug effects at each time period				Drug effects within each time period						
	Drug D	Time T	Order O	D+T	D+O	T+O	D+T+O	Baseline	2 h	6 h	24 h	Baseline	2 h	4 h	6 h	8 h	10 h	12 h	24 h
Resting heart rate	•	***		***				+		***	***								
Testing heart rate		*		*							***								
Letter cancellation — hits	**	+		***					+	***	***								
Letter cancellation — time	**	***		**					**	***									
Digit vigilance — hits				+															
Digit vigilance — time	+		+	***					***	**									
Digit vigilance — false alarm																			
Simple reaction time	+			+	+					*									
Choice reaction time																			
Choice reaction time accuracy																			
ARU																			
Depression	**	•				+								*	**	•	•	•	+
Irritability	***	***		***										*	***	**	***	**	**
Energy																			
Restlessness	***	*		***			•							+	*	***	***	***	**
Hunger																*			
Poor concentration	***	**		*										+	***	***	**		**
Urge to smoke	***	***		***										***	***	**	***	**	**
UEL																			
Stress	***						***					***	+	**			**	**	
Arousal	+	**												+					
Pleasure	***	**		+								•		*	**	**	***	**	

$+P < 0{\cdot}10$; $*P < 0{\cdot}5$; $**P < 0{\cdot}01$; $***P < 0{\cdot}001$ — Two-tailed values.

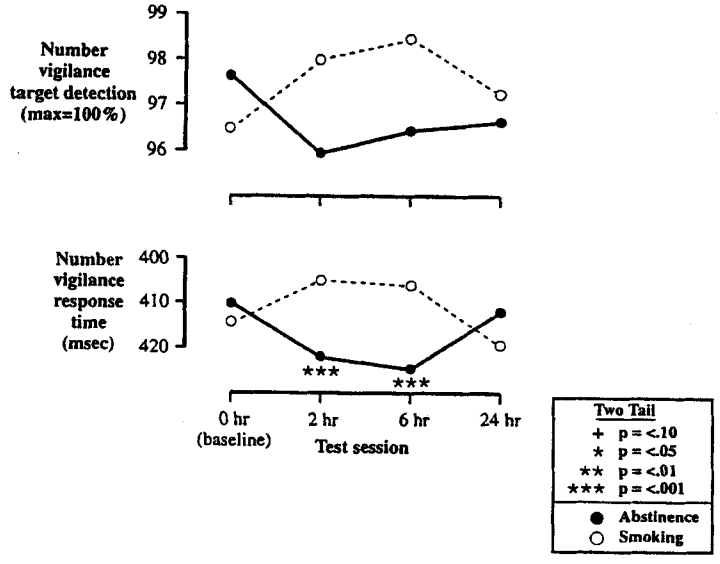

Figure 2. Number vigilance task performance under cigarette smoking and abstinence

drug × time interaction for response times was significant ($P < 0{\cdot}001$), with significantly slower responses after 2 and 6 h of abstinence, although not after 24 h (Figure 2, Table 3). Number vigilance target detections showed a similar general trend, although only the drug × time interaction approached significance ($P < 0{\cdot}10$, two-tail; Table 3). It should be noted that baseline detection rates were slightly higher pre-abstinence than pre-smoking (Figure 2). Thus although performance tended to improve under smoking, and deteriorate under deprivation, all drug condition comparisons were non-significant (Figure 2).

Resting heart rate was significantly affected by drug ($P < 0{\cdot}05$), time ($P < 0{\cdot}001$), and drug × time interaction ($P < 0{\cdot}001$; Table 3). Baseline heart rate values were generally maintained under smoking, but became reduced under deprivation. Again it should be noted that there was a borderline difference between conditions at baseline ($P < 0{\cdot}10$; Table 3), which meant that the magnitude of all subsequent deprivation effects was slightly underestimated. Nevertheless, significant differences were evident after 6 and 24 h of abstinence (Table 3), while a non-significant decrease was evident at the 2-h session. Similar findings occurred with heart rates during testing (Figure 3). With simple reaction time, all three ANOVA terms were statistically borderline ($P < 0{\cdot}10$; Table 3); response times were also significantly slower after 6 h of deprivation ($P < 0{\cdot}05$; Table 1). On the choice reaction time task, none of the ANOVA effects was significant (Tables 1, 3).

With the ARU smoking withdrawal questionnaire, five of the seven scales showed significant ANOVA effects: feelings of depression, irritability, restlessness, poor concentration, and urge to smoke (Table 2). Significant mood impairments were evident after 4 h of smoking deprivation, and continued at the later sessions, with the greatest decrements after 8–12 h of abstinence (Figure 3, Table 3). The two other ARU questions: feelings of hunger and energy, generated no significant ANOVA effects, although there was a tendency for increased hunger ratings under abstinence (particularly after 8 h — around 6 pm or mealtime; Table 2). On the UEL mood questionnaire, feelings of pleasure were generally higher after smoking than abstinence, with significant differences evident after 4–12 h. Pleasure ratings remained fairly constant over time during smoking, but deteriorated over the day during abstinence (Table 2). Feelings of arousal varied significantly over time ($P < 0{\cdot}05$, and were non-significantly higher under smoking than deprivation ($p < 0{\cdot}10$, two tail; Tables 2, 3). Feelings of stress demonstrated a significant drug effect ($P < 0{\cdot}001$), and a three-way interaction (drug × time × order, $P < 0{\cdot}001$; Table 3). Feelings of stress also differed significantly at baseline, which complicates further

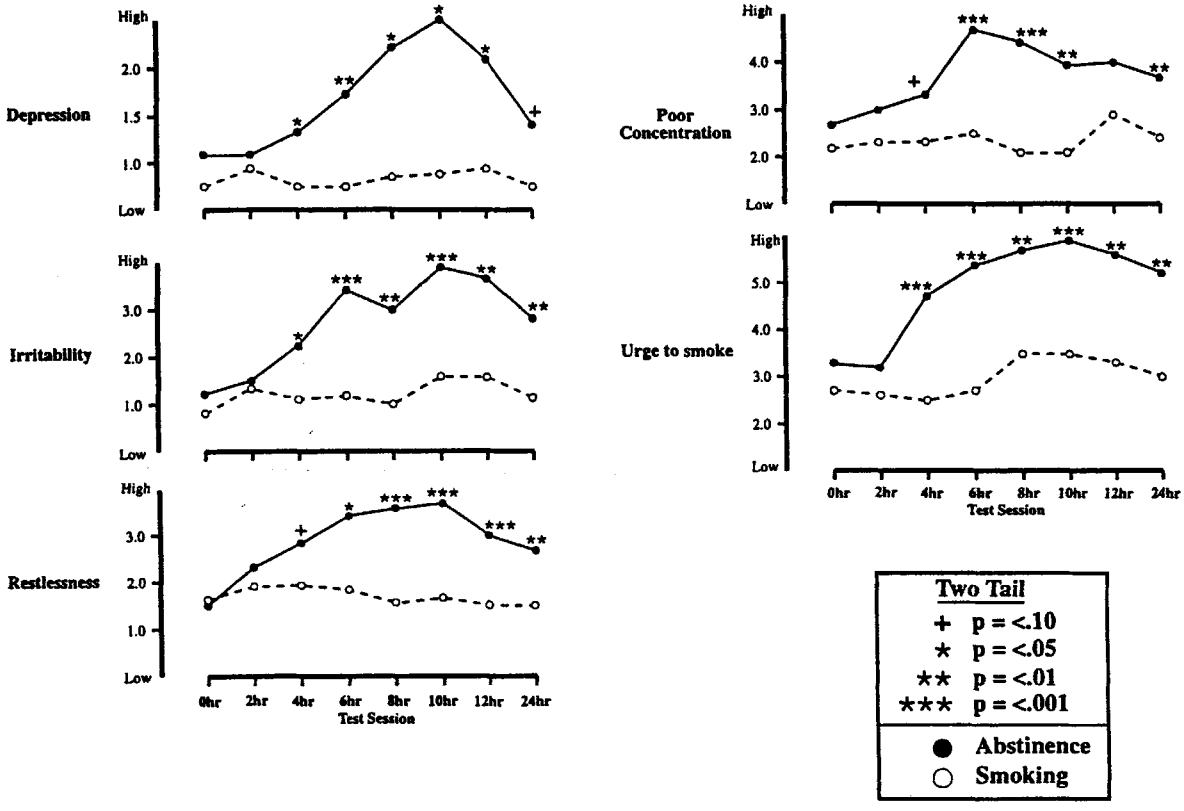

Figure 3. Feelings states over 24 h of cigarette smoking and abstinence

interpretation (Tables 2, 3); nevertheless, stress ratings tended to remain low during smoking, and high during abstinence (Table 2).

DISCUSSION

'Many smokers experience a range of adverse effects when they abstain from cigarettes. These include craving, increased irritability, depression, restlessness, hunger, and difficulty concentrating' (West and Russell, 1988, p. 563). These withdrawal symptoms were confirmed here, with abstinence leading to significant feelings of restlessness, depression, irritability, poor concentration, and increased urges to smoke (Figure 3). These findings agree not only with previous studies of cigarette smokers (Shiffman and Jarvik, 1976; Stizer and Gross, 1988; West *et al.*, 1989), but also with abstinence in regular tobacco chewers, and nicotine gum users (West and Russell, 1985; Keenan *et al.*, 1989). They therefore agree with the broader conclusion that cigarette abstinence in smokers, comprises just one form of nicotine depletion (Surgeon General, 1988; Hughes *et al.*, 1990).

Subjective withdrawal symptoms have been noted over a range of smoking cessation periods: 2-week (Shiffman and Jarvik, 1976), 4-week (West *et al.*, 1989), 10-week (Stizer and Gross, 1988), and 26-week periods (Hughes, 1992). They have also been noted in experimental withdrawal studies, where abstinence (generally for 1 day), is compared with an equivalent period of normal tobacco use (West and Russell, 1985, 1988; Keenan *et al.*, 1989; see Hughes *et al.*, 1990, p.325). These latter studies have generally monitored feelings at a single time point (generally 24 h), so currently there is little data on the time course of nicotine withdrawal symptoms during the first few hours of abstinence (West *et al.*, 1989; Foulds, 1994).

The present study found no significant mood changes at the 2 h session (Figure 3, Table 2). However, after 4 h of withdrawal, various feeling

states were significantly altered, with increased feelings of depression, irritability, stress, low pleasure, and urges to smoke, and borderline increases in feelings of restlessness, poor concentration, and low arousal (Figure 3, Table 2). These deleterious moods generally increased at the later sessions, so that between 4 and 24 h of abstinence, a wide range of abstinence symptoms was evident (Figure 3). Furthermore, although the 2-h data were non-significant, several moods showed a trend towards impairment (Figure 3). Mood reversals have previously been documented within the first hour of abstinence (Perkins *et al.*, 1992; Warburton, 1992; Parrott, 1994), but considerable individual variation in these mood changes has also been noted (Parrott, 1994, pp. 393–394). Different smokers may therefore develop abstinence symptoms at different rates, and this may have contributed to the non-significant group trends at the 2-h session. There was also a slight trend for smokers to report poorer moods at the 2-h session (Figure 3). Indeed, both groups showed subtle patterns of mood change over the day, possibly in response to environmental events such as meals, work/test demands, or the promise of rest and relaxation in the evening. Mood states are generally sensitive to various environmental factors and altered expectations (Thayer, 1989).

Smoking abstinence can affect not only feeling states, but also task performance. Active smokers generally display higher performance than deprived smokers, on various measures of sustained attention: rapid visual information processing, the Mackworth clock test, and letter cancellation (Williams, 1980; Wesnes and Warburton, 1983; Revell, 1988; Hasenfrantz *et al.*, 1989; Parrott and Craig, 1992; Wesnes and Parrott, 1992). However as with the subjective mood data, there is little data on their time course (Foulds, 1994). In the present study, letter cancellation was significantly impaired at the 2-h and 6-h sessions, while digit vigilance demonstrated a broadly similar pattern (Figures 1, 2). This decrement in sustained attention ability cannot be explained as a speed/accuracy tradeoff, since detection accuracy and response were impaired in parallel (Table 1). Task performance was only assessed four times each condition, and future studies should sample a wider range of time periods. This could be facilitated through the use of portable actigraphs, or hand-held computerized test systems.

Abstinence symptoms at the 24-h session held in the morning, were generally less marked than during the afternoon/evening the previous day. This was evident with several mood and performance variables, although it was not present with the physiological heart rate data (Tables 1–3, Figures 1–3). There seems to be three possible explanations for this circadian effect. Firstly, deprivation effects may build up afresh each day. Smokers start the morning with a degree of overnight nicotine depletion, but this increases over the day if they remain abstinent. Empirical support for this explanation comes from Schneider and Jarvik (1984), who monitored mood states during the morning, afternoon, and evening, over 4 days of abstinence. The highest withdrawal ratings were found during the evenings, while the lowest occurred on the mornings each day (Figure 1 in Schneider and Jarvik, 1984). A second explanation is that at the beginning of the day, *all* smokers are suffering from overnight nicotine depletion. Thus any difference between experimental and control groups will be lowest during the morning (since both groups are somewhat deprived). The third explanation is that it reflects an experimental design artefact. Deprived subjects knew that they would be able to smoke on completion of the 24 h session (i.e. on leaving the building), and this may have acted as an incentive for faster responding and better moods.

It is difficult to decide between these three explanations. The pharmacokinetics and pharmacodynamics of nicotine provide some support for the first two models (Russell, 1989; Benowitz, 1990), while indirect support for the third comes from Snyder *et al.* (1989). They monitored task performance over 10 days of withdrawal, and found peak performance decrements after 24–48 h of abstinence. Unfortunately they did not have a control group of normal smokers, so that time of day (circadian), and learning (repetition) effects, were confounded with drug (abstinence) effects. Thus their findings do not provide clear empirical evidence on the development of abstinence symptoms over time. Nevertheless, no significant decrements were evident at their final (10 day) session, following which smoking was allowed, agreeing with the third explanation noted above.

The present 24-h data can be discussed in conjunction with Hughes (1992), who monitored withdrawal over 2, 4, 7, 14, 30, 90, and 180 days post-cessation. This enables the time course for smoking withdrawal symptoms to be broadly outlined. Hughes (1992) found that anxiety,

irritability, restlessness, difficulty concentrating, and a composite withdrawal score, were all highest after 2 days of abstinence, then lessened in severity over subsequent sessions. Overall therefore, abstinence symptoms seem to develop within the first few hours, peak during the first few days, then decline over subsequent weeks (Figures 1–3; Snyder *et al.*, 1989; Hughes, 1992). Furthermore, the timescale for objective and subjective withdrawal symptoms also seem to be fairly similar. It should be noted that the present findings question the concept of the 'minimally deprived' smoker. A number of studies have tested smokers who have abstained from smoking for only a few hours. These have been termed 'minimally deprived', and any mood/performance changes interpreted as genuine psychological gains. The current findings question that interpretation, and suggest instead that these changes may reflect the reversal of abstinence effects (either partially or wholly).

The opposing psychological effects of smoking and abstinence, have been summarized by two contrasting models. The nicotine resource model, suggests that smoking generates genuine mood/performance gains, while abstinence reflects a return to baseline (Warburton, 1992). The deprivation reversal model, suggests that abstinence generates deleterious levels of mood and task performance, while smoking simply restores normal levels of psychological functioning (Parrott, 1994, 1995a,b). The present data do not allow these alternative explanations to be distinguished; their aim was simply to document the time profile for abstinence symptoms. In order to compare these two explanatory models, equivalent data from non-smoker controls is required, so that is the focus for our present study (Parrott and Garnham, unpublished). However, several further topics also need to be investigated. Firstly, the degree of individual variation in the development of abstinence symptoms, since differences in initial onset, maximal severity, and subsequent decline, are each likely. A second topic is the circadian profile of smoking withdrawal symptoms; this would help answer the question (raised earlier), of whether abstinence symptoms build-up afresh each day. Thirdly, the mood/performance effects of smoking, need to be directly related to the mood/performance effects of abstinence. This could answer the question of whether there is a direct link between the psychological functions served by smoking, and the withdrawal symptoms experienced during cessation.

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