Title: Self-rated everyday and prospective memory abilities of cigarette smokers and non-smokers: A web-based study.

Heffernan TM[1], Ling J[2], Parrott AC[3], Buchanan T[4], Scholey AB[1], Rodgers J[5]

Full Reference:

Heffernan, TM., Ling, J., Parrott, AC., Buchanan, T., Scholey, AB., & Rodgers, J. (2005). Self-rated everyday and prospective memory abilities of cigarette smokers and non-smokers: A web-based study. *Drug and Alcohol Dependence, 78,* 235-241

[1]Human Cognitive Neuroscience Unit, Department of Psychology, Northumbria University, Newcastle-upon-Tyne, NE1 8ST, UK.

[2]Psychology Section, University of Teesside, Middlesbrough, TS1 3BA, UK.

[3]Recreational Drugs Research Group, School of Psychology, University of East London, London, E15 4LZ, UK.

[4]Department of Psychology, University of Westminster, London, W1B 2UW, UK.

[5]Department of Clinical Psychology, University of Newcastle, Newcastle-upon-Tyne, NE1 7RU, UK.

Author for correspondence: Thomas M Heffernan, Human Cognitive Neuroscience Unit, Department of Psychology, Northumbria University, Newcastle-upon-Tyne, NE1 8ST, UK. Email: tom.heffernan@unn.ac.uk. Tel. 0191-2274037. Fax 0191-2273190

Abstract

The present study examined self-ratings of two aspects of everyday memory performance: long-term prospective memory - measured by the Prospective Memory Questionnaire, and everyday memory - measured by the Everyday Memory Questionnaire. Use of other substances was also measured and used as covariates in the study. To ensure confidentiality and to expand the numbers used in previous studies, an Internet study was carried out and data from 763 participants was gathered. After controlling for other drug use and strategy use, the data from the PMQ revealed that smokers reported a greater number of long-term prospective memory errors than non-smokers. There were also differences between light and heavier smokers in long-term prospective memory, suggesting that nicotine may have a dose-dependent impact upon long-term prospective memory performance. No significant differences were found between the groups on the EMQ. These findings suggest there are selective memory deficits associated with smoking and that long-term prospective memory deficits should be added to the growing list of memory problems associated with cigarette use.

KEYWORDS: nicotine, prospective memory, PMQ, everyday memory, EMQ

1. Introduction

The acute effects of cigarette smoking on memory task performance have been investigated in a number of studies, using a variety of measures. However, reviews of the effects of nicotine on human cognitive performance have concluded that the findings are very mixed (Heishman et al., 1993; Roth et al., 1992; Sherwood, 1994; Wesnes and Parrott, 1992). For instance, Roth et al., (1992, p.253.) noted: 'Smoking and nicotine effects on memory are contradictory. Improvement, no change, and impairment have all been observed'. There are numerous factors that need to be taken into account, with one of the most crucial being nicotine abstinence. When smokers are deprived of nicotine, they typically demonstrate mood and cognitive deficits, so that the apparently positive psychobiological effects of nicotine may often reflect the reversal of abstinence symptoms (Parrott and Garnham, 1998; Williams, 1980). Sakurai and Kanazawa (2002) investigated the effects of smoking either no, one or two cigarettes, on Buschke's selective reminding (memory) task, in non-deprived smokers. Performance on both the memory task and two other cognitive tests remained unchanged at the 'normal' level of non-smoker controls. It can also be difficult to separate memory from other cognitive functions, so that fluctuations in concentration ability may influence memory skills indirectly (Wesnes and Parrott, 1992, p.148-9). Furthermore plasma nicotine levels fluctuate in parallel with smoke inhalation patterns. This means that memory storage, consolidation and retrieval, are all occurring under constantly changing background levels of nicotine. These factors are extremely difficult to control in acute dose studies, which is why the effects of tobacco smoking on human memory functions remain unclear (Heishman et al., 1993; Roth et al., 1992; Sherwood, 1994; Waters and Sutton, 2000).

Less is known about the chronic effects of cigarette smoking on everyday cognitive function. However given the well-documented effects of tobacco on measures such as cardiovascular health indices and oxygen-bound haemoglobin (Glantz and Parmley, 1995), it might be predicted that smokers may exhibit compromised cognitive abilities. An alternative approach is therefore to assess the chronic effects of tobacco/nicotine use on memory ability. There may be specific aspects of memory that represent areas of concern for smokers and this formed the focus of the present study.

Two important aspects of day-to-day memory function are prospective memory and everyday cognitive failures. Prospective memory (PM) refers to the process of remembering to do things at some future point in time (Brandimonte et al., 1996). Examples of prospective memory include remembering to attend a particular function - such as a party, or to carry out a particular task at some future point in time - such as remembering to pay a bill on time, lock your door after leaving the house, and so on. PM has only recently been subjected to systematic empirical research ranging from laboratory studies to self-rated assessments (e.g. Brandimonte et al., 1996; Ellis et al., 1999). The Prospective Memory Questionnaire (PMQ), developed by Hannon et al., (1995) is a self-rating scale that requires participants to record the number of times their prospective memory has failed them within a given period of time. The PMQ contains a number of sub-scales that measure various aspects of memory, as well as gauging the number of strategies used to aid memory. The PMQ has proved to be a useful tool in estimating the effectiveness of PM in a number of settings. These include its use as a neuropsychological instrument in the study of brain damaged patients (Hannon et al., 1995) and it has recently been used to explore self-rated prospective memory deficits in regular users of ecstasy, marijuana and alcohol abuse

(Heffernan et al., 2001a; Heffernan et al., 2001b; Heffernan et al., 2002; Rodgers et al., 2003). In addition, the PMQ correlates well with objective measures of prospective memory (Hannon et al., 1995). The Everyday Memory Questionnaire (EMQ) was developed by Sunderland et al., (1983). The EMQ focuses on common memory lapses in everyday activities such as telling someone a story or joke that you have already told them, or having to go back and check whether you have done something that you meant to do. The EMQ has proved useful in measuring everyday lapses associated with a range of substances such as ecstasy and marijuana (Heffernan et al., 2001b).

The present study investigated the everyday memory skills of smokers in comparison with non-smokers using the Internet as a medium for data collection. We asked participants to describe their current use of legal psychoactive drugs (e.g. alcohol, cigarettes), and their lifetime use of illicit recreational drugs (e.g. amphetamine, cocaine, ecstasy/MDMA, others). We also asked them to complete the two self-rating memory questionnaires: the EMQ and the PMQ. Our questionnaire also covered the extent of current use of cigarettes, and thus we were also able to compare light and moderate smokers with heavier, more nicotine dependent, smokers. We chose to conduct the study via the Internet for a number of reasons. One is the large sample sizes accessible through such methods, and hence high statistical power available for multivariate analyses. Another is that many of the recreational drugs we wished to ask about are illegal in most countries. A web-based design allows respondents a measure of anonymity not usually feasible in laboratory studies, and thus increases the likelihood that they will disclose such "sensitive" information (Rogers et al, 2003). While use of the Internet for research is relatively new, there is a growing body of evidence that indicates that, given that appropriate methodology is

used, web based research is both viable and valid and indeed offers many advantages over traditional techniques for some research questions (see, e.g., Birnbaum, 2000).

2. Method and subjects

Data from 763 participants remained after screening for multiple submissions from the same computer and submissions that appeared to be fraudulent or mischievous (such as where very young participants claimed to have doctoral degrees) was conducted. Of these remaining participants, 465 (60.9%) were female. The modal age group was 21-25 (32%). The majority of these respondents came from Europe (71%) and many were well educated, having some University or college education (31%). The majority of participants (n = 465; 61.3%) stated that they were non-smokers. Eighty-two participants smoked 1-4 cigarettes (or equivalent) per day (10.8%), 125 smoked between 5 and 14 cigarettes a day (16.5%) and 87 smoked 15 cigarettes a day or more (11.5%).

A website was created for the purposes of data acquisition which could be accessed via a number of different addresses (e.g. www.drugresearch.org.uk). Memory was assessed using two self-report questionnaires. The first was the Everyday Memory Questionnaire (EMQ). This is a valid and reliable self-report measure of common memory lapses in everyday activities comprising of 27 statements (Sunderland et al., 1983). Participants respond on a nine-point scale ranging from 'Not at all in the last six months' to 'More than once a day'. There are no sub-scales within this questionnaire. The higher the score the more forgetting is evident. Statements include "telling someone a story or joke that you have told them once already" and "forgetting where things are normally kept or looking in the wrong place for them".

Prospective memory was assessed using the Prospective Memory Questionnaire (PMQ), which is a valid and reliable self-report measure (Hannon et al., 1995). The PMQ provides measures of three aspects of PM on a series of nine-point scales. Fourteen questions measure short-term habitual PM (e.g. “I forgot to turn my alarm clock off when I got up this morning”). Fourteen items measure long-term episodic PM (e.g. “I forgot to pass on a message to someone”). Ten questions measure internally-cued PM (e.g. “I forgot what I wanted to say in the middle of a sentence”). The PMQ provides a measure of self-reported errors in the previous week, or month or year, depending upon the specific questionnaire item. These scales range from 1 to 9, with greater scores indicating more faulty prospective memory. In addition, 14 further questions make up the ‘techniques to remember’ scale which measures the number of strategies used to aid memory (e.g. “I rehearse things in my mind so I will not forget to do them”). Scores on this latter scale range from 1 to 9; higher scores indicate greater use of memory aids. The strategy scale was included since differences in PM are associated with differences in strategy use (Hannon et al., 1995).

Tobacco and other drug use were assessed by a version of the UEL Recreational Drug Use Questionnaire (Parrott, 2000). Respondents estimated their level of use of tobacco as well as other drugs (alcohol, ecstasy, amphetamines, cocaine, LSD, barbiturates, opiates, magic mushrooms, anabolic steroids, solvents and cannabis). This was slightly modified for use on the Web with some drug descriptions amended to make it more suitable for an international sample. Participants were required to select a typical frequency from a drop-down menu. For all questions regarding drugs, a ‘prefer not to answer’ option was also included. The smoking question read “Tobacco: roughly how many cigarettes (or equivalent) do you usually

smoke per day?" In response, participants could select 'non smoker', '1-4 cigarettes or equivalent per day', '5-14 cigarettes or equivalent per day', 'More than 15 cigarettes or equivalent per day', or 'Prefer not to answer'.

Participants also answered a number of demographic questions (age, sex, location, occupation and education) and questions relating to their participation (how they found out about the study, whether they were currently under the influence of any substance, and whether there was any reason their data should not be used in analyses). These instruments were all presented as interactive forms on a single Web page. The final variable measured was mistakes made when completing the questionnaire. If participants submitted an incomplete form they were informed of this and requested to supply the missing data then resubmit the form. The number of times each participant made such a mistake was recorded.

Ethical approval came via University of Westminster. There was a brief introduction to the study that also explained that participants' responses were both voluntary and confidential. Each participant clicked an informed consent button on the web site reading "I understand the nature of the study and wish to continue". Participants were recruited using several methods including messages posted to relevant Internet discussion groups, links from online experiments, notices on WWW pages and announcements in our home institutions. Participants first saw an informed consent page. This page informed participants that the study was designed to investigate everyday behaviour and recreational drug use. There was also a link to a statement on anonymity and confidentiality. Participants then saw a page bearing brief instructions, demographic items, the EMQ, PMQ and drug use questionnaires, and questions about their participation. After completing all the items, participants clicked on a button labelled "Finished" at the bottom of the page.

Participants who had not answered all the questions saw a page indicating this, which asked them to return to the form and fill it out completely prior to resubmission. Those who had answered all the items saw a debriefing page. This thanked them, outlined the purpose of the study, provided links to Web sites with information about drugs, and also a link to a page where a summary of results would be posted on conclusion of the study. An email contact address was also provided for respondents who wished to submit feedback or ask questions.

3. Findings.

Prior to the analysis, the psychometric properties of the EMQ and the subscales of the PMQ were examined. According to Hannon et al., (1995), the model underlying the PMQ has four factors, corresponding to the subscales described above. However, exploratory factor analysis with extraction of four principal components followed by Varimax rotation, did not support this model. The items comprising the long-term and techniques to remember scales clearly loaded together on discrete factors in the expected way. However, the items comprising the short-term and internally-cued subscales had their highest loadings scattered across three different factors, and did not cluster together in the way one would expect if they loaded on discrete latent constructs. Therefore, in the current dataset there are no grounds for saying that these subscales measure anything, let alone the constructs delineated by Hannon et al., (see Buchanan et al., 2002). For current purposes we may conclude that the PMQ short-term and internally cued scales are not psychometrically satisfactory with the current sample. These scales were therefore not included in the analysis: any conclusions based on data derived from them would be unsound. The other measures were more satisfactory: Cronbach's alpha values were high, demonstrating good

reliability, for PMQ long-term (alpha = .85) and techniques to remember scales (alpha = .89), and the EMQ (alpha = .94).

The effect of reported cigarette consumption on each of the remaining memory scores (EMQ, PMQ long term scale) and the number of mistakes made completing the questionnaire were examined by means of multivariate analyses of covariance (MANCOVA). As previous research has indicated that the use of cannabis, ecstasy and alcohol are all associated with deficits in cognitive performance and on the PMQ and EMQ in particular (e.g. Rodgers et al., 2001), use of these drugs was employed as a covariate in the analyses. In addition, the 'techniques to remember scale' of the PMQ was also included as a covariate because use of memory strategies may affect memory performance.

There was no effect of level of reported smoking on the number of errors made when completing the study F (3, 752) = 1.13, p = 0.35. Analysis indicated that level of reported smoking had a significant effect on the long-term scale of the PMQ, F (3, 752) = 4.78, $p < .01$ (see Table 1). Pairwise comparisons (with Bonferroni adjustment) indicated that participants who reported smoking 15 or more cigarettes per day reported significantly more problems than either non-smokers ($p < .01$) or than those who stated they smoked 5-14 cigarettes per day ($p < .05$). An analysis of the first and second order polynomials across the levels of reported smoking was conducted in order to determine dosage effects; these analyses indicated that the effect of dosage was a linear one ($p < .01$; see Table 1). There was no effect of cigarette consumption on score on the EMQ, F (3, 752) = 1.32, p = 0.26; see Table1).

*********Table 1 about here********

A further investigation of the influence of smoking on PMQ-LT score helped to understand the contribution made by heavy use of cigarettes to cognitive deficits (Cohen's *d* effect sizes are given in brackets). A typical heavy smoker is likely to report 21.59% more problems with long term aspects of prospective memory than someone who does not smoke ($d = 0.43$) and to report 16.46% more problems than individuals who say they have a moderate level of smoking (5-15 cigarettes per day, $d = 0.40$).

4. Discussion.

Acute dose studies of cigarette smokers have often concluded that smoking enhances memory performance (Waters and Sutton, 2000). However since they have involved briefly deprived smokers, the apparent cognitive gains may reflect the temporary reversal of abstinence effects (Hale et al., 1999; Krebs et al., 1994). Williams (1980) found no effects of mild, moderate and strong cigarettes on an

immediate memory task in overnight nicotine-deprived smokers. However it was also noted that: 'Absolute gain scores were misleading therefore more account had to be taken of pre-smoking performance' (Williams, 1980, p. 87). Williams found that when the gain scores were regressed on the pre-smoking values, performance remained impaired under sham smoking, but improved significantly in the two high dose cigarette conditions. The effects of cigarette smoking have been investigated in numerous acute dose studies, and improvements, deteriorations, and unchanged memory performance levels have all been reported (Roth et al., 1992; Wesnes and Parrott, 1992). The cognitive functioning of cigarette smokers is affected by numerous potentially confounding factors, with the effects of nicotine deprivation and reinstatement difficult to disentangle, which is why the mood and cognitive effects of nicotine can be so variable (Heishman et al., 1994; Sherwood, 1993). In an explanatory model, Parrott (1998) suggested that cognitive performance was often slightly enhanced when plasma nicotine levels peaked, but that this period was brief and transitory. In-between cigarettes, cognitive performance deteriorated to a level *below* that of non-smokers. Thus the main effects of nicotine dependency were to cause mood lability and variable cognitive performance over the day (Parrott, 1998; also Adan and Sanchez-Turet, 2000).

The present study revealed that cigarette smokers reported significantly worse everyday long-term prospective memory function than non-smokers, this was evident after controlling for the use of other substances and the number of strategies used to aid remembering. These findings are consistent with nicotine dependency as a source of psychobiological distress. Thus smokers experience peak nicotine levels for only a brief period after each cigarette, but then in between cigarettes their plasma nicotine levels gradually fall (Sakurai and Kanazawa, 2002). Thus for each piece of

information that needs to be memorised, its initial sensory reception, then its consolidation and storage, and finally its subsequent retrieval, will each be conducted against a background of changing and uncertain plasma nicotine levels. Only for a brief period after each cigarette are nicotine levels at their peak, and in between cigarettes the plasma nicotine levels gradually fall (Sakurai and Kanazawa, 2002). This may help explain why cigarette smokers reported memory problems and impairments. The current findings also revealed some interesting differences between light and heavier smokers, suggesting that nicotine may have a dose-dependent impact upon everyday prospective memory.

The present study also revealed that, although smokers did report elevated everyday memory problems on the EMQ, there were no significant differences between the groups. This latter finding suggests that other aspects of everyday cognition remain unaffected by smoking, such as spatial memory, conversational monitoring, monitoring short-term everyday activities, all of which are assessed by the EMQ. It should also be noted that only 3 of the 27 statements on the EMQ pertain to prospective remembering, which may not be insufficient to compare prospective memory performance across the two questionnaires.

The current findings thus agree with the extensive literature on the adverse psychobiological effects of nicotine dependency. These results suggest that prospective memory - which is an important aspect of everyday cognitive functioning - should be included in the list of neuropsychological deficits associated with smoking. Adolescent smokers who take up smoking prospectively report increased levels of stress and depression in later years, whereas adult smokers who quit smoking report subsequent improvements in their feelings of stress and depression (Cohen and Lichtenstein, 1990; Goodman and Capitman, 2000; McGhee et al., 2000). There is

now an extensive body of prospective studies showing that the uptake of smoking leads to a range of psychobiological problems (summarised in Parrott, 2003). The supposed mood 'benefits' of smoke inhalation only reflect the temporary reversal of abstinence effects, and the repetitive experience of irritability and poor moods in-between cigarettes, directly causes smokers to suffer from heightened levels of stress and depression; this explanatory model is described more fully elsewhere (Parrott, 1999, 2000, 2003).

5. Conclusions

In conclusion, the present findings show that cigarette smokers report more memory problems than non-smokers. This is apparent in the higher rates of long-term prospective memory impairments reported by smokers. It also appears that some aspects of everyday memory, as measured by the EMQ, remained unaffected. Further memory studies of tobacco smokers are however required, such as prospective studies of adolescents who take up smoking, or the effects of smoking cessation on memory skills. Laboratory studies typically assess the immediate effects of nicotine reinstatement in deprived smokers and as a consequence are likely to show nicotine in an optimal light. Yet even then, cigarette smokers often only show memory levels equivalent to non-smoker controls (see Figure 1a in Sakurai and Kanazawa, 2002). What is needed are real life memory tasks, performed under realistic conditions of intermittent smoking, where plasma nicotine levels are constantly changing. It is predicted that these are the conditions when the storage and retrieval of information in memory will be most problematic. One such approach might include video simulations wherein the participant is required to remember to carry out certain activities at particular locations reached on the video - a recent development in the

prospective memory literature which represents an ecologically valid and objective task (see Titov and Knight, 2001). Finally, future researchers should include ratings of depression in their participants, since there is a correlation between smoking and clinical depression (Breslau et al., 1992; Hall et al., 1993) and depression and self-beliefs in one's own memory capabilities (Hendricks et a., 2002), although ascertaining clinical depression using the Internet as a medium might prove difficult.

References

Adan, A., Sanchez-Turet, M. 2000. Effects of smoking on diurnal variations of subjective activation and mood. Hum. Psychopharmacol. 15, 287-294.

Birnbaum, M.H. (2000). Psychological Experiments on the Internet. San Diego: Academic Press.

Brandimonte, M., Einstein G.O., McDaniel, M.A. 1996. Prospective Memory: Theory and applications. Lawrence Erlbaum Associates, New York.

Breslau, N., Kilbey, M., Andreski, P. 1992. Nicotine withdrawal symptoms and psychiatric disorders: findings from an epidemiological study of young adults. Am. J. Psychiatry. 149, 464-469.

Buchanan, T., Ali, T., Heffernan, T.M., Ling, J., Parrott, A.C., Rodgers, J., Scholey, AB. 2002. Psychometric properties of online self-report memory questionnaires: The EMQ and PMQ. The 5th German Online Research Conference (GOR), Stuttgart, Germany, 10th-11th October 2002.

Cohen, S., Lichtenstein, E. 1990. Perceived stress, quitting smoking, and smoking relapse. Health. Psychol. 9, 466-478.

Ellis, J., Kvavilashvili, L., Milne, A. 1999. Experimental tests of prospective remembering: the influence of cue-event frequency on performance. Br. J. Psychol. 90, 9-23.

Glantz, S.A., Parmley, W.W. 1995. Passive smoking and heart disease: mechanisms and risk. JAMA. 273, 1047-1054.

Goodman, E., Capitman, J. 2000. Depressive symptoms and cigarette smoking among teens. Pediatrics. 196, 748-755.

Hale, C.R., Gentry, M.V., Meliska, C.V. 1999. Effects of cigarette smoking on lexical decision-making. Psychol. Rep. 84, 117-120.

Hall, S., Munoz, R., Reus, V., Sees, K. 1993. Nicotine, negative affect and depression. J. Consult. Clin. Psychol. 61, 761-767.

Hannon, R., Adams, P., Harrington, S., Fries-Dias, C., Gibson, M.T. 1995. Effects of brain injury and age on prospective memory self-rating and performance. Rehab. Psychol. 40, 289- 297.

Heffernan, T.M., Ling, J., Scholey, A. 2001a. Subjective ratings of prospective memory in ecstasy users. Hum. Psychopharmacol. 16, 339-344.

Heffernan, T.M., Jarvis, H., Rodgers, J., Scholey, A.B., Ling, J. 2001b. Prospective memory, everyday cognitive failures and central executive functions in recreational users of 'ecstasy'. Hum. Psychopharmacol. 16, 1-6.

Heffernan, T.M., Moss, M., Ling, J. 2002. Subjective ratings of prospective memory in chronic heavy alcohol users. Alcohol. Alcohol. 37, 269-271.

Heishman, S.J., Taylor, R.C., Henningfield, J.E. 1994. Nicotine and smoking: a review of the effects on human performance. Exp. Clin. Psychopharmacol. 2, 345-395.

Hendricks, M.P.H., Aldenkamp, A.P., van der Vlugt, H., Alperts, W.C.J., Vremeulen, J. 2002. Memory complaints in medically refractory epilepsy: Relationship to epilepsy related factors. Epilepsy. Behav. 3, 165-172.

Krebs, S.J., Petros, T.V., Beckwith, B.E. 1994. Effects of smoking on memory for prose passages. Physiol. Behav. 56, 723-727.

McGee, R., Williams, S., Poulton, R., Moffitt, T. 2000. A longitudinal study of cannabis use and mental health from adolescence to early adulthood. Addiction. 95, 491-504.

Parrott, A.C. 1998. Nesbitt's Paradox resolved? Stress and arousal modulation during cigarette smoking. Addiction. 93, 27-39.

Parrott, A.C. 1999. Does cigarette smoking cause stress? Am. Psychol. 54, 817-820.

Parrott, A.C. 2000. Cigarette smoking does cause stress? Am. Psychol. 55, 1159-1160.

Parrott, A.C. 2003. Cigarette-derived nicotine is not a medicine. World J. Biol. Psychiatry. 4, 49-55.

Parrott, A.C., Garnham. N.J. 1998. Comparative mood states and cognitive skills of cigarette smokers, deprived smokers, and non-smokers. Hum. Psychopharmacol. 13, 367-376.

Parrott, A.C., Garnham, N.J., Wesnes, K., Pincock, C. 1996. Cigarette smoking and abstinence: comparative effects upon cognitive task performance and mood state over 24 hours. Hum. Psychopharmacol. 11, 391-400.

Rodgers, J., Buchanan, T., Scholey, A.B., Heffernan, T.M., Ling, J., Parrott, A. 2001. Self-reports of Memory Ability in Recreational Users of 'Ecstasy': a web-based study. Hum. Psychopharmacol. 16, 619-625.

Rodgers, J., Buchanan, T., Scholey, A.B., Heffernan, T.M., Ling, J., Parrott A.C. 2003. Patterns of drug use and the influence of gender on self reports of memory ability amongst ecstasy users: a web-based study. J. Psychopharmacol. 17. 379-386.

Roth, N., Luitger, B., Hasenfratzm, M., Battig, K., Knye, M. 1992. Smoking deprivation in early and late smokers and memory functions. Psychopharmacology. 106. 253-260.

Sakurai, Y., Kanazawa, I. 2002. Acute effects of cigarettes in non-deprived smokers on memory, calculation and executive functions. Hum. Psychopharmacol. 17, 369-373.

Sherwood, N. 1993. Effects of nicotine on human psychomotor performance. Hum. Psychopharmacol. 8, 155-184.

Sunderland, A., Harris, J.E., Baddeley, A.D. 1983. Do laboratory tests predict everyday memory? J. Verb. Learn. Verb. Behav. 22, 341-357.

Titov, N., Knight, R.G. 2001. A video-based procedure for the assessment of prospective memory. Appl. Cogn. Psychol. 15, 61-83.

Waters, A.J., Sutton, S.R. 2000. Direct and indirect effects of nicotine/smoking on cognition in humans. Addict. Behav. 25, 29-43.

Wesnes, K., Parrott, A.C. 1992. Smoking, nicotine, and human performance. In: A. Smith & D. Jones (Eds.). Factors affecting human performance, volume 2. Academic Press, London.

Williams, D.G. 1980. Effects of cigarette smoking on immediate memory and performance in different kinds of smoker. Br J Psychol 71, 83-90.

Table 1. Mean (and standard deviation) scores on Prospective Memory Questionnaire Long-Term (PMQ-LT) subscale and Everyday Memory Questionnaire (EMQ) by level of smoking

	Cigarettes per day			
	Non-smoker	1-4	5-14	15+
PMQ-LT	2.27 (.96)	2.46 (1.08)	2.37 (1.19)	2.76 (1.38)
EMQ	74.3 (28.2)	82 (27)	80.2 (31.8)	81.1 (35.5)