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EFFECTS OF THE COMMON COLD ON MOOD AND PERFORMANCE

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SUMMARY

Previous research has shown that both experimentally-induced and naturally occurring upper respiratory tract illnesses (URTIs) influence mood and mental functioning. None of the previous studies of naturally occurring colds has conducted appropriate virological assays to determine the nature of the infecting agent. This is an essential methodological step in studies of malaise associated with URTIs. The aim of this research was to investigate the effects of naturally occurring colds on mood and objective measures of performance. This was done by first conducting a cross-sectional comparison of 37 healthy people and 158 volunteers with colds and then a longitudinal study in which 100 volunteers developed colds and 87 remained healthy. Virological techniques were used to identify infecting agents and comparisons made across the different groups. The results showed that having a cold was associated with reduced alertness and slowed reaction times. These effects were observed both for colds where the infecting virus was identified and those where it was not. Similar effects were obtained for both rhinovirus and coronavirus colds. One may conclude that upper respiratory tract illnesses lead to a reduction in subjective alertness and impaired psychomotor functioning. This was true for both illnesses where the infecting agent was identified and for those clinical illnesses where no virus was detected. It is now important to identify the mechanisms linking infection and illness with the behavioural changes. Similarly, the impact of these effects on real-life activities such as driving needs examining. Finally, methods of treatment need to be developed which not only treat the local symptoms of the illnesses but remove the negative mood and the performance impairments. © 1998 Elsevier Science Ltd. All rights reserved.

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INTRODUCTION

Upper respiratory tract illnesses, such as influenza or the common cold, are widespread, frequent and a major cause of absenteeism from education and work. In addition, recent research has demonstrated that these illnesses reduce well-being and can impair the efficiency of mental functioning. Initial evidence for such effects came largely from anecdotal reports and case histories (Grant, 1972; Tye, 1960). Studies of experimentally-in-

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duced influenza and colds have confirmed that such illnesses produce performance impairments and the results can be briefly summarised as follows:

both colds and influenza have selective effects on mental performance, with only some aspects of being impaired. The profile of impairments has been found to be different in studies of influenza from those observed in experiments on the effects of colds;

influenza impaired detection of stimuli presented at uncertain times or unknown locations (Smith et al. 1987b, 1988). However, neither motor performance nor higher cognitive functions appear to be affected by influenza;

in contrast, the common cold impaired psychomotor function (e.g. hand–eye co-ordination; speed of psychomotor responses) but had little effect on either detection tasks or those involving higher functions (Smith et al. 1987a,b, 1989).

The effects of influenza have been replicated in a study of naturally occurring illnesses involving virological techniques to identify the infecting agent (Smith et al. 1993b). While studies of naturally occurring colds have confirmed that such illnesses reduce subjective ratings of alertness and lead to psychomotor slowing (Hall and Smith, 1996; Smith et al. 1995; Smith et al., 1997) no experiments have been conducted which relate these effects to the nature of the infecting virus. Indeed, we do not know whether confirmed infections produce similar effects to those clinical illnesses where the virus is unknown. In addition, the differences between influenza and cold infections suggest that the nature of the infecting agent may be crucial. Data from studies of experimentally-induced infections suggest that many effects of different cold producing viruses on performance are similar. However, subjective mood ratings have shown different effects of coronavirus colds and those following infection with rhinoviruses, with the coronavirus leading to reduced ratings of subjective alertness and the rhinovirus colds being associated with much smaller changes in mood (Smith et al., 1992). These differences may not reflect the viruses but may be due to variation in the severity or length of the cold. This issue was examined here. Research on naturally occurring colds (Hall and Smith 1996) has failed to replicate results obtained following infection with respiratory syncytial viruses (RSV). Given that it is unlikely that the young adults with naturally occurring colds had RSV infections it does appear plausible that even different cold producing viruses may produce different effects on mood and performance. This issue was addressed here by examining the effects of colds following rhinovirus and coronavirus infections.

The aims of the present study were to examine whether: (1) colds where the infecting virus has been identified lead to increased drowsiness and impaired performance; (2) different viruses (e.g. rhinoviruses vs. coronaviruses) produce similar or different effects; and (3) whether comparable effects are seen in colds where the virus can be identified and those where the aetiology of the illness is unknown.

METHOD

Two experimental designs were used to collect new data to address the current aims. The first involved a cross-sectional design comparing healthy volunteers with those with a cold. The second used a longitudinal, prospective design where subjects were tested when

healthy and then returned to the laboratory when they developed a cold. Volunteers who remained free from illness were subsequently recalled as healthy controls.

The following features were common to both studies.

Participants

In both studies the participants were recruited from a student volunteer panel. The samples participating in the studies were representative of the panel as a whole.

Time Frame of the Studies

Each study was carried out over the course of two 10 week terms.

Ethical Approval and Informed Consent

These studies were approved by the local ethics committee and carried out with the informed consent of the volunteers.

Definition of a Cold

A cold was defined as increased local nasal symptoms (both subjective and objective) but no systemic effects. Specifically volunteers completed a symptoms check list using a rating scale of 0 (not present)–4 (very severe). Those with a total score of 4 or more for sneezing, runny nose and blocked nose and who produced >0.2 g of nasal secretion in a 15 min period were included in the colds group. Nasal secretion was measured by having volunteers clear their nose. Fifteen minutes later they blew into a tissue which had previously been weighed and nasal secretion weight was determined by subtracting the dry weight of the tissue from the weight of the tissue plus nasal secretion.

Virological Assays

Nasopharyngeal swabs (for rhinovirus isolation) and blood samples were collected from all subjects and a convalescent blood sample was collected 4–6 weeks later (coronavirus infections were identified by antibody changes). For virus isolation the nasopharyngeal swabs were inoculated on to MRC-5 Ohio–Hela, Madin–Darby canine kidney, and C16 cells incubated and observed for viral cytopathic effect. Details of the procedure have been described previously (Nicholson et al. 1990). Coronavirus infection was identified by enzyme linked immunosorbent assay using OC43 and 229E antigens, as described previously (Kraaijeveld et al. 1980).

Measurement of Mood

The same method of assessing mood was used as in previous studies of upper respiratory tract illnesses (Smith et al., 1992). Mood ratings were recorded using bipolar visual analogue scales (scale = 0–50) presented on a computer screen (e.g. drowsy–alert, mentally slow–quick witted; see Smith et al. (1992), for the complete list). These 18 scales cluster on three factors—alertness, anxiety and hedonic tone. The factor scores were used in the statistical analyses reported here (to reduce the possibility of error due to multiple analyses).

Performance Tasks

Volunteers performed a simple reaction time task and a repeated numbers detection task. Again, these tasks were selected because they have been shown to be sensitive to effects of upper respiratory tract illnesses (Smith, 1990). It was predicted that subjects with a cold would be slower on the simple reaction time task but unimpaired on the detection task.

Simple Reaction Time Task

An empty square was presented on a computer screen and, when a target spot appeared in the centre of the square, the subject had to press a response button as quickly as possible. Subjects carried out the task for 10 min.

Repeated Digits Detection Task

A sequence of three digit numbers was presented in the centre of a computer screen at the rate of 100/min. Each number normally differed from the previous one, but $8 \times$ a minute a number was presented that was identical to the previous one. Volunteers had to detect these repeats and respond as quickly as possible. The task lasted for 3 min. Both accuracy of responding (number of targets correctly detected and number of false alarms) and speed of response were recorded.

Testing Procedure

In both studies testing was carried out between 1000 and 1200h. Participants were tested in a sound proof laboratory and conducted the tests in the following order: mood rating; simple reaction time task; repeated digits tasks.

Statistical Analysis

In the first study analyses of variance were carried out distinguishing the various groups. Post-hoc Tukey tests were then conducted to allow specific comparisons. In the second study a similar procedure was carried out but the baseline scores were used as covariates. This statistical technique removes unwanted individual variation.

EXPERIMENT 1

Participants

One hundred and ninety-five students (mean age 20.8 years; 98 males, 97 females) took part in the study. Thirty-seven healthy volunteers were tested, 109 colds where no virus was identified, 33 colds following corona virus infection and 16 following rhinovirus infection.

Results

The results showed that all the colds groups felt significantly less alert and had lower hedonic tone (were less happy and sociable) than the healthy controls (alertness factor: $F_{3,191} = 10.5$, $p < .0001$; Hedonic tone: $F_{3,191} = 5.2$, $p < .005$). These results are shown in Table I. Tukey tests showed that the different colds groups were not significantly different from one another.

Table I. Mean ratings of alertness and hedonic tone and simple reaction time (ms) for the various groups (S.E.S. in parentheses)

Group	Healthy	Colds no virus identified	Coronavirus colds	Rhinovirus colds
1. Alertness rating (high scores = more alert)	245 (11.7)	188 (5.4)	189 (9.7)	165 (13.8)
2. Hedonic tone (high scores = happy, sociable)	199 (7.6)	171 (3.7)	172 (7.6)	161 (9.4)
3. Simple RT	366 (7)	418 (14)	397 (27)	411 (35)

Simple reaction time was also significantly slower in all colds groups (F 3.191 = 3.89, $p < .01$). This is also shown in Table I. In contrast, there was no significant effect of having a cold on the accuracy or speed of responses in the detection task.

The next issue examined was whether, for the colds groups only, there were associations between symptom severity and duration and the mood and performance scores. Similarly, correlations between nasal secretion weight (an objective measure of symptoms) and the mood and performance scores were computed. There were significant correlations between the symptom checklist scores and ratings of alertness and hedonic tone (alertness: -0.23 ; hedonic tone: -0.23 , both p 's $< .05$), with higher symptom severity going with greater negative affect. This is not too surprising as both sets of measures were subjective ratings and the correlations probably reflect individual differences in these ratings. None of the correlations with length of cold nor nasal secretion were significant and the performance measures were not related to the symptom scores.

The results from this study confirm previous findings of studies of both experimentally-induced and naturally-occurring illnesses. Furthermore, they extend our knowledge of naturally-occurring illnesses by showing that effects generalise across different viruses and that the objective changes in performance do not reflect symptom severity or duration. The next study tried to replicate these results using a prospective design.

EXPERIMENT 2

Participants

A panel of 200 students was recruited. Of these, 187 completed the study (mean age = 21.2 years; 101 females, 86 males). Eighty-seven subjects remained healthy over a 10 week period and were re-tested as healthy controls. Seventy subjects developed colds but no virus could be identified, 16 had colds following coronavirus infection and 14 following rhinovirus infection. None of the subjects had participated in Experiment 1.

Results

In order to remove the effects of individual differences in mood and performance analyses of covariance with the baseline data as covariates and the second session data as dependent variables were used. Preliminary analyses showed that length of time between first and second test session had little effect and covariance was a valid technique here due to the parallel regression lines of the colds and healthy groups.

Table II. Mean ratings of alertness and hedonic tone and mean simple reaction time (ms) for the various groups (S.E.S. in parentheses)

Group	Healthy	Colds no virus identified	Coronavirus colds	Rhinovirus colds
1. Alertness rating (high scores = more alert)	223 (6.6)	176 (7.4)	173 (15.8)	158 (16.9)
2. Hedonic tone (high scores = happy, sociable)	185 (4.7)	168 (5.3)	150 (11.3)	165 (12.1)
3. Simple RT	363 (10)	414 (11)	400 (20)	409 (23)

The results again showed that all colds groups felt less alert and had lower hedonic tone than the healthy subjects (alertness: $F_{3,183} = 10.24$, $p < .0001$; Hedonic tone: $F_{3,183} = 3.9$, $p < .01$). Tukey tests showed there were no significant differences between the different colds groups. These data are shown in Table II. Similarly, reaction times were slower in the colds groups ($F_{3,183} = 4.39$, $p < .005$). These effects are shown in Table II. Again, there were no significant differences between the groups with regard to performance of the repeated digits task.

Correlations between symptom scores (colds groups only) and mood and performance measures again showed that high symptom scores were related to greater negative mood (alertness correlation: -0.27 , $p < .05$; Hedonic tone: -0.32 , $p < .01$). None of the other correlations were significant.

DISCUSSION

These two studies confirm that naturally occurring colds reduce subjective alertness and hedonic tone and impair psychomotor tasks. Detection tasks involving selective attention were unimpaired by these illnesses. The effects of the cold were present in illnesses following coronavirus infection and when the infecting agent was a rhinovirus. Illnesses following a verified infection produced similar effects to those where no infecting agent was isolated and where classification was based on clinical symptoms and signs. Overall, these results confirm findings at the MRC Common Cold Unit with experimentally induced illnesses and previous studies of real life colds where no virology was carried out. The mood effects were related to subjective reports of symptoms but were not related to length of illness or amount of nasal secretion. The slowing of simple reaction time was not correlated with subjective reports of symptom severity nor duration of illness or amount of nasal secretion. The phenomena appear, therefore, to be genuine and robust. Indeed, the magnitude of the impairments should also be noted (a slowing of reaction time of $\sim 10\%$) as they are comparable with known hazards such as working at night or consuming a moderate amount of alcohol (Smith et al., 1987b). It should also be pointed out that other research shows that these illnesses not only have direct effects on mood and performance but can exacerbate the effects of other factors (volunteers with colds show larger impairments when exposed to noise (Smith et al., 1993a) or given small amounts of alcohol (Smith et al., 1995)). Further research must identify the neuroimmunological mechanisms underlying the effects, assess the impact on real life activities, and aim to

develop therapies which not only provide symptomatic relief but remove the behavioural problems produced by upper respiratory tract illnesses.

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