THE PSYCHOLOGY OF THE COMMON COLD: AN INTEGRATED APPROACH

BACKGROUND

Upper respiratory tract illnesses, such as influenza and the common cold, are frequent, widespread and a major cause of absenteeism from work and education. It has been recognised for some time that there is enormous individual variation in susceptibility to these illnesses and in the severity of the symptoms. This has led to research that has considered the role of psychosocial characteristics and the importance of health related behaviours such as smoking and alcohol consumption. The psychological characteristics that have been covered include personality (Broadbent et al., 1981), stress (see Cohen & Williamson, 1990, for a review; Cohen, Tyrrell & Smith, 1991; Cohen et al., 1998), positive life events (Stone et al., 1992; Evans et al., 1996), social support (Cohen et al., 1997) and coping (Turner-Cobb & Steptoe, 1996). The most convincing demonstrations of the role of psychological factors have come from studies of experimentally-induced colds. A detailed overview of our research on this topic is given in Cohen and Smith (1996). The main points of the research on stress and the common cold can be summarised as follows. Previous studies of this area suggested that there was an association between stress and colds. However, much of the research had methodological problems such as failure to control exposure, small sample sizes and lack of an adequate model of stress. In addition, it was unclear whether stress influenced susceptibility to infection or sensitivity to symptom reporting. Similarly, the pathways linking stress and illness had not been examined in detail. For example, it was unclear whether stress had a direct effect on the immune system or whether it altered health-related behaviours such as smoking and drinking and produced an effect via this route. Many of the previous problems were overcome by studying experimentally-induced colds. The results showed that the incidence of colds increased in a linear dose-response relationship with stress. This was observed across a range of different viruses and was due to stress altering susceptibility to infection not the development of symptoms following infection (Cohen, Tyrrell & Smith, 1991). Appraisal of stress and the emotional response to stress were associated with susceptibility to infection whereas exposure to stressful life events was associated with increased symptom severity (Cohen, Tyrrell & Smith, 1993a). These effects of stress did not reflect health-related behaviours although smoking increased susceptibility to colds and moderate alcohol consumption had a protective effect in non-smokers (Cohen et al., 1993b). Similarly, there is evidence that diet can influence susceptibility to colds, with breakfast cereal consumption being associated with lower susceptibility to colds (Smith & Rees, 2000) and low vitamin C intake associated with increased susceptibility (Cohen et al., 1997). The closure of the Common Cold Unit, Salisbury, meant that it was no longer possible to study experimentally-induced colds in the UK although this approach has been continued by in the USA by Cohen and his colleagues. More recent studies of naturally occurring illnesses have investigated patients who often develop more serious problems when they get a cold (e.g., an exacerbation of asthma – Smith & Nicholson, 2001) and those with high levels of stress (e.g., chronic fatigue syndrome patients – Smith et al., 1999). Results from these studies have confirmed the associations between stress and susceptibility to colds.

Research on the effects of experimentally induced colds and influenza and performance (see Smith, 1990; Cohen & Smith, 1996, for reviews) has shown that these illnesses produce selective performance impairments. For example, influenza impairs tasks where it is not known when or where a target stimulus will appear whereas colds lead to psychomotor slowing (Smith et al., 1987a, 1987b, 1988). These effects have been confirmed in studies of naturally occurring colds and influenza (Hall & Smith, 1996; Smith et al., 1993, 1995, 1997, 1998, 1999a, 1999b, 2000), with some of the studies using virological assays to confirm the nature of the infecting agent (Smith et al., 1993, 1998). Upper respiratory tract illnesses also induce mood changes (see Smith et al., 1992) and again these often differ depending on whether one is investigating colds or influenza. Influenza usually leads to an increase in systemic symptoms (e.g., increased temperature, headaches, myalgia) whereas the symptoms of a cold are usually nasal. It is unclear whether the behavioural changes produced by such illnesses reflect the different symptoms and this issue was investigated here. Similarly, the performance changes may, at least in part, be a product of the mood states induced by the illnesses. This topic was considered here to provide further information about the mechanisms underlying the performance changes produced by upper respiratory tract illnesses.

Overall, knowledge of the Psychology of the Common Cold has greatly increased in recent years. However, future research must integrate the two main areas that have been considered and attempt to determine whether psychosocial variables and health related behaviours are risk factors for the behavioural malaise induced by the common cold. Two alternative hypotheses are suggested by the literature. The first
is that factors which influence the susceptibility to the physical symptoms of the disease will not be related to the mood and performance changes induced by the illness. This is based on three main pieces of evidence. First, results show that performance impairments are not restricted to the time when a person is symptomatic but may also be observed in the incubation period of the illness and in convalescence. Secondly, there is no correlation between nasal symptom severity and the performance changes. Finally, different biological pathways are involved in the development of symptoms and the CNS changes thought to underlie malaise. The second hypothesis is that factors such as stress may not only be important with regard to susceptibility to illness but may also influence the nature and magnitude of the behavioural changes produced by the illness. Indeed, the CNS changes following infection are almost identical to those seen in the stress literature. Furthermore, individuals with URTIs have been shown to be more sensitive to the effects of environmental stressors, such as noise (Smith et al., 1993b), fatigue over the working day (Smith et al., 2000) and alcohol (Smith et al., 1993).

AIMS AND OBJECTIVES

The first objective of the proposed research was to investigate whether variables that are risk factors for susceptibility to colds and severity of the illnesses are also important with regard to the mood changes and performance impairments (malaise) induced by the illness. The variables considered were (a) personality (specifically introversion-extraversion, trait anxiety and neuroticism) (b) stress (life-events, daily hassles, perceived stress) (c) other psychosocial characteristics (e.g. social support; locus of control), and (d) health-related behaviours such as alcohol consumption, smoking, exercise and consumption of breakfast. The research aimed to determine whether paradigms used to study illness incidence (e.g. diary studies) can be adapted to also assess the behavioural malaise. Similarly, prospective designs typically used to investigate the behavioural effects of the common cold were used and the extent to which they identified risk factors for susceptibility, illness severity and malaise assessed.

METHODS

Two main designs were used to address the research questions. The first used a large sample of students and involved a baseline assessment, when all were healthy, and then followed them over a period of 3 months during which time some developed colds and others did not. The second was a diary study of a general population sample to examine the incidence of colds over a 12 week period. Both methods involved baseline administration of questionnaires measuring personality, stress, psychosocial factors and health-related behaviours. Similarly, both involved assessment of mood and performance of tasks known to be sensitive to the effects of upper respiratory tract illnesses (psychomotor tasks; cognitive vigilance tasks). All of the methods used are well-established and reliable validated measuring instruments were used. Details of these are shown below.

Measures of personality: Introversion-Extraversion (Eysenck & Eysenck, 1967); Trait anxiety (Spielberger et al., 1971).

Stress measures: Negative Life Events (Cohen, Tyrrell & Smith, 1991); Hassles (Kanner et al., 1981); Perceived stress scale (Cohen et al., 1983); Negative affect (Zevon & Tellegen, 1982).

Psychosocial factors: Social support (interpersonal self-evaluation list, Cohen & Hoberman, 1983); Locus of control (Paulhus, 1983); Self-esteem (Fleming & Watts, 1980)

Health-related behaviours: Smoking, alcohol consumption, exercise, and sleep (Cohen, Smith & Tyrrell, 1991); consumption of breakfast (Smith, 1998); caffeine consumption (Brice & Smith, in press).

Computerised visual analogue mood rating: (Smith et al., 1995).

Computerised assessment of cognitive performance - psychomotor tasks (simple reaction time; cognitive vigilance; five choice serial response task; focused attention choice reaction time task; categoric search choice reaction time task – see Hall & Smith, 1996).

STUDY 1

Participants
The participants were 498 students (216 male, 282 female; mean age 21.6 years).
Informed consent
All participants were required to sign a consent form which outlined the nature of the study, explained that they were free to withdraw at any time, and confirmed the confidentiality of the data.

Procedure
Participants were recruited when healthy and at this point completed the psychosocial questionnaires and mood and performance tasks. They were asked to return if they developed an URTI (within 6-96 hours of the symptoms developing). Those who did not develop an URTI during the 12 week period were recalled as healthy controls.

Symptoms and signs
On the second visit the volunteers completed a validated symptom check-list measuring both nasal and systemic symptoms (rated on a scale of 0=not present to 4=very severe). Nasal secretion over a 45 minute time period was also weighed.

RESULTS

1. Factor analysis of the questionnaire measures
Factor analysis revealed a 12 factor solution, with all of the factors making conceptual sense. The factors were: social support; extraversion; hassles/perceived stress; alcohol consumption; negative life events; breakfast; locus of control; exercise; smoking; positive life events; sleep/caffeine consumption, and use of vitamin supplements.

2. A comparison of those who developed upper respiratory tract illnesses (URTIs) and those who remained healthy
One hundred and eighty eight of the participants developed URTIs. This group did not differ from those who remained healthy in terms of demographics. Those with an illness had a mean symptom score of 10.7 (s.e.0.3). The mean nasal secretion weight for this group was 1.3 grams. It should be noted that both the symptom score and nasal secretion weight showed large variation (symptom range: 3 to 26; nasal secretion weight: 0-15 grams).

A factor analysis of the symptoms revealed two factors corresponding to systemic symptoms (headache, sore-throat, fever, cough) and nasal symptoms (sneezing, runny nose, blocked nose). Again, there was considerable variation in the severity of the different symptom types (see Table 1).

Table 1: Frequency of severity of specific symptoms reported by participants who developed URTIs (N=188)

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>0 = not present</th>
<th>1 = Slight</th>
<th>2 = Moderate</th>
<th>3 = Severe</th>
<th>4 = Very Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runny nose</td>
<td>4.3</td>
<td>15.6</td>
<td>39.8</td>
<td>34.9</td>
<td>5.4</td>
</tr>
<tr>
<td>Blocked nose/stuffy nose</td>
<td>7.3</td>
<td>27</td>
<td>35.4</td>
<td>24.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Sore throat</td>
<td>5.1</td>
<td>33.3</td>
<td>35.6</td>
<td>20.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Sneezing</td>
<td>12.2</td>
<td>34.3</td>
<td>41.3</td>
<td>11.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Cough</td>
<td>9.4</td>
<td>35.7</td>
<td>31</td>
<td>20.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Headache</td>
<td>17.7</td>
<td>32.9</td>
<td>27.4</td>
<td>15.9</td>
<td>6.1</td>
</tr>
<tr>
<td>Fever</td>
<td>50.4</td>
<td>29.8</td>
<td>14.9</td>
<td>4.1</td>
<td>0.8</td>
</tr>
</tbody>
</table>

3. Mood and Performance
Those who developed an illness had a more negative mood than those who remained healthy. This was observed for all the mood dimensions and for ratings carried out both before and after the performance tasks. These effects, expressed as differences from baseline, are shown in Table 2.
Table 2: Differences in mood changes between baseline and test for participants who developed URTIs and those who remained healthy (tested by t-test or Mann Whitney)

| Pre-performance mood |  |  |
|----------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Changes from baseline to test | Mean (SE) No URTI (N = 251) | Percent change | Mean (SE) URTI group (N = 142) | Percent change | t or Mann-Whitney | df | p value |
| Alert mood | -8.73 (3.06) | -1.3% | -92.91 (5.40) | -35.1% | 4844.0 | 1, 391 | 0.00001* |
| Hedonic tone | -5.88 (2.21) | -1.1% | -43.46 (3.80) | -19.8% | 8743.5 | 1, 391 | 0.00001* |
| Anxious mood | -1.42 (1.26) | -3.9% | -7.08 (1.87) | -8.9% | -2.58 | 1, 391 | 0.01 |

| Post performance mood |  |  |
|-----------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Changes from baseline to test | Mean (SE) No URTI (N = 251) | Percent change | Mean (SE) URTI group (N = 142) | Percent change | T or Mann-Whitney | df | p value |
| Alert mood | -4.57 (3.39) | -1.6% | -74.53 (5.46) | -31.5% | 6922.5 | 1, 391 | 0.00001* |
| Hedonic tone | -3.43 (2.25) | -1.3% | -34.89 (3.21) | -16.9% | -8.18 | 1, 391 | 0.00001 |
| Anxious mood | -0.52 (1.15) | -2.3% | -5.19 (1.8) | -2.3% | 15478.5 | 1, 391 | 0.03* |

* Tested by Mann-Whitney  Negative values indicate decrement in mood

Those with an illness had slower response times in the simple reaction time, serial response, focused attention and categoric search tasks. This confirms previous findings in the area. In addition, those with an illness also showed more lapses of attention in that they detected fewer targets in the repeated digits cognitive vigilance task and were less accurate in the categoric search and serial reaction time tasks. These effects, expressed as changes from baseline, are shown in Table 3.
Table 3: Differences in performance change between baseline and test for participants who developed URTIs and those who remained healthy

* Tested by Mann-Whitney. Negative values indicate improvement in performance.

**Focused attention task:**

<table>
<thead>
<tr>
<th>Changes from baseline to test in:</th>
<th>Mean (SE) No URTIs N=309</th>
<th>Percent change</th>
<th>Mean (SE) URTI group N=188</th>
<th>Percent change</th>
<th>T</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean reaction time to target presented with asterisk or alone.</td>
<td>-2.86 (1.52)</td>
<td>-0.4%</td>
<td>9.19 (3.02)</td>
<td>2.6%</td>
<td>3.94</td>
<td>1,495</td>
<td>0.0001</td>
</tr>
<tr>
<td>Mean reaction time to targets when distractors are present, whether they agree</td>
<td>-4.38 (1.48)</td>
<td>-0.8%</td>
<td>6.91 (2.86)</td>
<td>2.0%</td>
<td>3.86</td>
<td>1,495</td>
<td>0.0001</td>
</tr>
<tr>
<td>Mean reaction time to encode new information.</td>
<td>3.02 (1.06)</td>
<td>N/A</td>
<td>7.40 (1.39)</td>
<td>N/A</td>
<td>2.53</td>
<td>1,495</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Categoric Search Task:**

<table>
<thead>
<tr>
<th>Changes from baseline to test</th>
<th>Mean (SE) No URTI N=309</th>
<th>Percent change</th>
<th>Mean (SE) URTI group N=186</th>
<th>Percent change</th>
<th>T</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean reaction time to targets presented alone or with asterisk</td>
<td>-7.60 (1.77)</td>
<td>-1.3%</td>
<td>2.03 (3.12)</td>
<td>0.6%</td>
<td>31667.0</td>
<td>1,493</td>
<td>0.06*</td>
</tr>
<tr>
<td>Mean reaction time taken to encode new information (ms).</td>
<td>-3.72 (1.25)</td>
<td>N/A</td>
<td>2.55 (1.95)</td>
<td>N/A</td>
<td>32652.0</td>
<td>1,493</td>
<td>0.01*</td>
</tr>
<tr>
<td>Mean accuracy to targets presented alone or with asterisk.</td>
<td>-0.04 (0.01)</td>
<td>-0.9%</td>
<td>0.0004 (0.02)</td>
<td>0.3%</td>
<td>2.35</td>
<td>1,493</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**Serial reaction time task:**

<table>
<thead>
<tr>
<th>Changes from baseline to test in:</th>
<th>Mean (SE) No URTI group N=252</th>
<th>Percent change</th>
<th>Mean (SE) URTI group N=142</th>
<th>Percent change</th>
<th>T</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of trials completed during task</td>
<td>-2.94 (2.61)</td>
<td>-1.7%</td>
<td>-11.84 (4.22)</td>
<td>5.7%</td>
<td>14027.0</td>
<td>1,392</td>
<td>0.0004*</td>
</tr>
<tr>
<td>Total percentage correct through the duration of the task</td>
<td>-0.31 (0.33)</td>
<td>-0.4%</td>
<td>0.01 (0.08)</td>
<td>0.0%</td>
<td>20416.5</td>
<td>1,392</td>
<td>0.02*</td>
</tr>
</tbody>
</table>

**Simple reaction time task:**

<table>
<thead>
<tr>
<th>Changes from baseline to test in:</th>
<th>Mean (SE) No URTI (N = 309)</th>
<th>Percent change</th>
<th>Mean (SE) URTI (N=188)</th>
<th>Percent change</th>
<th>Mann Whit</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total mean reaction time for task.</td>
<td>3.07 (1.97)</td>
<td>1.6%</td>
<td>28.95 (2.99)</td>
<td>10.2%</td>
<td>40028.0</td>
<td>1,495</td>
<td>0.00001*</td>
</tr>
</tbody>
</table>

**Detection of repeated digits task**

<table>
<thead>
<tr>
<th>Changes from baseline to test in:</th>
<th>Mean (SE) No URTI group N=245</th>
<th>Percent change</th>
<th>Mean (SE) URTI group N=140</th>
<th>Percent change</th>
<th>T</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total reaction time for task</td>
<td>-3.27 (4.55)</td>
<td>-0.1%</td>
<td>11.75 (6.94)</td>
<td>2.7%</td>
<td>1.88</td>
<td>1,383</td>
<td>0.06</td>
</tr>
<tr>
<td>Total number of hits during task</td>
<td>-0.29 (0.17)</td>
<td>-1.0</td>
<td>0.94 (0.22)</td>
<td>5.5%</td>
<td>2.30</td>
<td>1,388</td>
<td>0.02</td>
</tr>
</tbody>
</table>
4. **Psychosocial factors and susceptibility to URTIs**
No significant differences were found between the psychosocial scores of those who did and did not develop an URTI.

5. **Health-related behaviours and susceptibility to URTIs**
Those who developed an URTI were more frequent consumers of alcohol (mean = 2.98 days/week, s.e.0.13) than those who remained healthy (mean=2.58 days/week, s.e.= 0.1). This effect was significant (p < 0.05).

6. **Time to become ill**
The present methodology not only allowed analysis of factors relating to the occurrence of illness but also how quickly participants became ill. Three variables had a significant effect on the time taken to become ill. Smokers became ill more quickly (mean=44.7 days s.e.6.7) than non-smokers (mean=69.9 days s.e.3.8). Those who consumed alcohol more frequently also develop URTIs more quickly. Those who developed colds more rapidly also reported a higher frequency of hassles.

7. **Factors associated with symptom severity and type**

   **Total symptom score**
   Preliminary analyses showed that frequency of consuming alcohol, impulsivity, social support and interpersonal control were all associated with higher symptom scores. When all of these variables were entered into the regression equation impulsivity was the only significant predictor (r=0.23). Those who took longer to develop an URTI had significantly higher symptom scores than those who became ill more quickly.

   **Systemic symptoms**
   Impulsivity was also the only significant factor in these analyses (r=0.23).

   **Nasal symptoms**
   Personal control was a significant predictor of nasal symptoms (r=0.30). Those who took longer to develop an URTI had significantly higher nasal symptom scores than those who became ill more quickly.

   **Nasal secretion weight**
   Again, personal control was the only significant predictor (r=0.21).

8. **Psychosocial factors, health-related behaviours and mood changes associated with URTIs**
Social support and negative life events were the best predictors of changes in pre-task alertness (social support: r=-0.25; negative life events: r=-0.24). A different pattern emerged when post-test alertness was examined, with negative life events (-0.27) and trait anxiety (0.24) being the significant predictors. Exercise emerged as the best predictor of illness-induced changes in hedonic tone (pre-task hedonic tone: r=-0.19; post-task hedonic tone: r=-0.19). Use of multi-vitamins predicted changes in anxiety (pre-task: r=0.19; post-task: r=0.20).

9. **Symptoms and mood changes**
Total symptom score was associated with changes in all of the mood dimension. This effect was entirely due to the systemic symptoms (e.g.changes in pre-task alertness: r=0.37) and neither the nasal symptom score nor nasal secretion weight were associated with the mood changes.
In the next analysis both the psychosocial factors and symptom scores were entered into the regression. Changes in alertness were predicted by systemic symptoms. Exercise was the best predictor of changes in hedonic tone, and use of multi-vitamins predicted changes in anxiety.

10. **Days to URTI and mood changes**
Those who developed an URTI more quickly had significantly greater mood changes than those who remained healthy for a longer time.

11. **Associations between performance changes, psychosocial factors and health-related behaviours**
There were few significant associations between the performance changes induced by the URTIs and the psychosocial or health-related behaviour variables. Indeed, the number of significant effects was no greater
than one would expect by chance and there was no consistent pattern across the different performance measures.

12. Associations between symptoms and performance changes
Neither nasal symptoms nor nasal secretion weight were correlated with performance changes. Systemic symptoms did predict the changes in the simple reaction time task, with higher symptom scores being associated with greater slowing of reaction time. (r=0.18).

13. Associations between mood and performance changes
Few associations were found between the mood and performance changes. Pre-task changes in hedonic tone were associated with slowing in the simple reaction time task (r=0.20). When both symptoms and mood changes were entered into the regression it was found that only changes in hedonic tone were associated with slowing of simple reaction time.

14. Days to develop an URTI and performance changes
Those who developed an URTI more quickly had greater impairments of performance than those who remained healthy longer. As those who became ill more quickly had lower symptom scores this is further evidence of the independence of the performance changes and the symptom severity.

CONCLUSIONS
The first study confirmed that upper respiratory illnesses lead to psychomotor slowing and impaired performance of tasks requiring sustained attention. Subjective reports of mood were also more negative in the ill group. Previous investigations of these topics have often been too small scale to determine whether the performance changes reflect the severity and nature of symptoms or whether they are due to the changes in mood. The present findings show that they are largely independent of such effects. This is consistent with the view that different biological pathways are involved. Similarly, it supports the findings of studies which show that sub-clinical infections can affect performance.

The performance changes were also not modified by psychosocial characteristics and health-related behaviours. However, these factors were important with regard to development of the illnesses and the nature and magnitude of the symptoms. Susceptibility to illness was found to be related to alcohol consumption, smoking and frequency of daily hassles. These results confirm previous findings, although it is impossible to tell from this type of studies whether these factors are having an effect on immune system functioning or are related to exposure to viruses. Different psychosocial factors were related to symptoms, with those high in impulsivity and personal control having the highest symptom scores. Those who developed illnesses later in the study also had higher symptom scores. This may reflect a bias in the reporting of symptoms or the presence of different types of virus at different times of year. The mood changes associated with the illnesses were found to be related to both the symptoms and to health-related behaviours. Systemic symptoms were the best predictor of changes in alertness, whereas exercise and use of multi-vitamins were correlated with changes in hedonic tone and anxiety respectively.

Overall, these results suggest that factors that influence susceptibility to URTIs do not have an effect on the performance changes produced by the illness. This study has used a paradigm designed to assess the performance effects associated with a single illness. The next study used an alternative methodology to determine whether the above conclusion applied to effects seen over a fixed time period.

STUDY 2
Details of the diary study
This methodology has been used to examine susceptibility to colds in chronic fatigue syndrome patients and controls (Smith et al., 1999; Smith & Rees, 2000). At baseline the participants completed the psychosocial questionnaires and carried out the computerised assessment of performance (simple reaction time and repeated digits tasks) and rating of mood (Zevon & Tellegen, 1982). They were then given a diary to complete on a weekly basis. This collected information on the presence/absence of upper respiratory tract illnesses, the nature of symptoms, use of medication and general physical and mental health that week. In addition, it provided an indication of mood (anxiety/depression), fatigue and cognitive difficulties. When volunteers developed a cold they returned to the laboratory and objective measures of symptom
severity (temperature, weight of nasal secretion) were recorded. In addition, the mood rating and performance tasks were repeated to give an indication of the impact of the illness on behaviour. All volunteers returned to the laboratory once every four weeks and repeated the mood and performance tasks. This provided control data from the healthy volunteers that allowed comparison with those who developed colds at specific time points. The study lasted for 12 weeks and different samples were tested in the autumn and spring, as different types of virus are present at these times. Analysis consisted of three main stages. The first examined associations between baseline measures of personality, stress, psychosocial factors, health-related behaviours and susceptibility to colds and severity of the illness. This aimed to establish whether previous results could be replicated with the present methodology. Following this the associations between the above factors and changes in performance and mood produced by the illnesses were investigated. Finally, relationships between recent health (as indicated in the diaries) and illness parameters and behavioural malaise were examined.

Participants
One hundred volunteers (51 female, 49 male; mean age 49 years, range 22 to 76 years) from a community sample participated in the study.

Incidence of URTIs
Forty-seven participants developed at least one URTI during the course of the study. Details of the illnesses are shown in Tables 4 and 5.

Table 4: Average length of URTIs, mean subjective severity and whether medication was taken, reported in weekly diaries by 47 participants reporting illness

<table>
<thead>
<tr>
<th>Average length of reported URTIs (days)</th>
<th>Subjective rating of severity of URTIs: values expressed as %</th>
<th>% using medication</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very mild</td>
<td>Mild</td>
</tr>
<tr>
<td>9.28 (0.41)</td>
<td>57.3</td>
<td>22.6</td>
</tr>
</tbody>
</table>

Table 5: Means, (standard errors in parentheses) for symptoms reported in diaries for participants who developed URTIs (N=47).

<table>
<thead>
<tr>
<th>Symptoms measure</th>
<th>Diary study Mean (s.e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total symptoms</td>
<td>20.34 (2.06)</td>
</tr>
<tr>
<td>Systemic symptoms</td>
<td>10.14 (1.00)</td>
</tr>
<tr>
<td>Nasal symptoms</td>
<td>10.19 (1.28)</td>
</tr>
</tbody>
</table>

RESULTS

Associations between measures taken at baseline and susceptibility to URTIs
There were no significant demographic differences between those who developed URTIs and those who remained healthy. Those who became ill were sub-divided into those who reported a single illness and those who reported more than one illness. Those who had more than one illness reported significantly more negative life-events in the last 12 months. None of the other psychosocial variables differed across the groups. Those who developed multiple illnesses differed from the other groups in terms of health-related behaviours in that they were less likely to eat breakfast and consume alcohol.

Associations between measures taken at baseline and symptoms
Frequency of exercise was correlated with the total symptom score ($r=-0.35$) and also the systemic ($r=-0.35$) and nasal symptom scores ($r=-0.28$). Systemic symptoms were also correlated with perceived stress ($r=0.35$), trait anxiety ($r=0.39$), loneliness ($r=0.42$) and breakfast consumption ($r=-0.34$).

Associations between measures taken at baseline and use of medication
There were no significant differences between those who used medication during their illness and those who did not for any of the psychosocial or health-related behaviours variables.
Effects of illness on weekly reports of subjective well-being
Subjective well-being was assessed each week using ratings of mental and physical fatigue, anxiety, depression, and concentration and memory problems. Those who remained healthy showed very consistent levels over the course of the study. Those who became ill reported more problems than those who remained healthy (see Table 6).
Table 6: Differences in subjective well-being between those who developed URTIs, during the weeks when they reported URTIs, and those who remained healthy

<table>
<thead>
<tr>
<th>Mean (s.e) over 10 weeks No URTI group (N=53)</th>
<th>Mean (s.e) URTIS group (N=47)</th>
<th>T</th>
<th>df</th>
<th>P&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.89 (0.53)</td>
<td>9.35 (0.70)</td>
<td>-2.82</td>
<td>1.98</td>
<td>0.006</td>
</tr>
</tbody>
</table>

N.B. Higher score indicates poorer well-being

The effect of having an illness on well-being is shown as a within subject comparison in Table 7.

Table 7: Differences in well-being, between weeks with URTIs and weeks when healthy (URTIs only, N=47)

<table>
<thead>
<tr>
<th>Mean (s.e) ‘well’ weeks</th>
<th>Mean (s.e) of weeks an URTI reported</th>
<th>T</th>
<th>df</th>
<th>P&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.89 (0.59)</td>
<td>9.21 (0.70)</td>
<td>-4.21</td>
<td>45</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Further analyses considered whether well-being changed in the week prior to the illness and whether problems persisted into the week after the symptoms had gone. Neither analysis showed significant differences. Those who reported more daily hassles showed the greatest drop in well-being when they were ill, and taking medication helped to reduce the effect of the illness on well-being.

Laboratory testing of effects of mood and performance

Volunteers with an illness had a more negative mood and slower response times on the repeated digits task. There were no significant associations between the mood changes and the performance changes. Similarly, the performance changes were not associated with symptoms, psychosocial variables and health-related behaviours.

CONCLUSIONS

This second study has again demonstrated that upper respiratory tract illnesses are associated with behavioural effects. Like the first study, the results have also shown an independence between the changes in performance and factors which may influence susceptibility to illness and the nature and severity of symptoms. Previous research has identified that negative life events are associated with susceptibility to URTIs and this was confirmed here, although the association was restricted to the likelihood of having multiple illnesses during the study. This variable was also associated with health-related behaviours, namely alcohol consumption and eating breakfast. Again, these findings confirm previous results (Cohen et al., 1993a; Smith & Rees, 2000). Stress, lack of social support and breakfast consumption were also found to be correlated with the presence and severity of systemic symptoms, and these results support findings from previous research.

DISCUSSION

The results from two large scale studies have provided evidence of the effects of URTIs on mood and performance. Similarly, they have shown that psychosocial factors and health-related behaviours may influence susceptibility to URTIs and the nature and extent of the symptoms. Both studies have failed to demonstrate associations between variables influencing illness susceptibility and/or severity and the mood and performance changes. Specific differences were observed in the profile of effects found in the two studies. This may reflect the methods used, the samples or the types of illness. Both studies investigated naturally occurring illnesses and it was impossible to identify any infecting agent. Some of the illnesses may not even have been viral infections and others may have been the result of infection with a range of different viruses. Given this “noise” in the data one might expect that only the most robust effects will be present in studies using different methods and samples. The performance effects were found to be largely independent of the characteristics of the illnesses and the psychosocial profile of the person. This plausibly explains why results on this topic have been so consistent, with the present results replicating findings obtained in studies of experimentally-induced URTIs. In contrast to this, studies of susceptibility to viral infections need to control exposure and when this is not done results will be variable.
Activities
A large amount of parallel research has been carried out to confirm and extend the results obtained here. Some examples of this are shown below:

Symptoms, motivation and performance: results from a study conducted in collaboration with the University of Cincinnati confirm that the effects of the common cold on performance do not reflect symptoms or motivational changes (Matthews et al., 2001).

Stress, URTIs and asthma: This has confirmed the role of stress and health-related behaviours in susceptibility to URTIs and exacerbation of asthma.

Other infections or illnesses: The effects of other illnesses have been considered in a range of studies. With regard to infections, collaborative research with Charles University, Prague, has shown that infection with toxoplasmosis impairs performance (Havlicek et al, 2001). Research on hayfever has shown few performance impairments which supports the view that nasal symptoms per se are not associated with decreased performance.

Collaborations
The research has led to international collaborations with Charles University, Prague, the University of Tasmania, the University of Cincinnati, and Procter & Gamble Ltd. Results have been presented at meetings in Egham, Glasgow, Cincinnati and Tasmania.

Outputs
All of the studies have been written up in report form. Papers based on these reports are being prepared for submission to journals.

Further research priorities
Further research on the impact of minor illnesses in industry and education is desirable. Awareness of the effects of performing when ill should also be increased and possible counter measures considered. Our knowledge of the mechanisms underlying these effects is increasing and further study of the cognitive processes that are impaired, the changes in brain chemistry and the role of mediating factors is now required. Similarly, further research on the mechanisms underlying the associations between psychosocial factors, health-related behaviours and URTIs is required.
REFERENCES


