Psychoneuroendocrinology (2013) 38, 2003—2009

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Effects of upper respiratory tract illnesses and stress on alertness and reaction time

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Received 19 September 2012; received in revised form 14 March 2013; accepted 14 March 2013

KEYWORDS
Upper respiratory tract illness;
Stress;
Alertness;
Reaction time;
Negative life events;
Hassles;
Malaise

Summary
Context: It has been shown that stress increases susceptibility to the upper respiratory tract illnesses (URTIs) such as the common cold. Compared to healthy individuals, those with URTIs also report reduced alertness and have slower reaction times.
Objective: The present study investigated whether those with an URTI who had been exposed to stressful events showed greater impairments than either individuals without a cold or those with an illness and low stress exposure.
Methods: A prospective cohort study was conducted. The volunteers (360 young adults) were recruited when healthy and completed questionnaires measuring negative life events, personality and health-related behaviours. They also rated their alertness and performed a simple reaction task. If volunteers developed an upper respiratory illness they returned to the laboratory and completed a symptom check list and had nasal secretion and sub-lingual temperature recorded. They also completed a questionnaire measuring recent daily hassles. Alertness and simple reaction time were also recorded again. Those who did not develop a cold were recalled as controls 12 weeks after the start of the study. Analyses of covariance were carried out comparing colds/no colds and high/low stress groups. Baseline measures were included as covariates.
Results: 356 participants completed the study. 120 developed URTIs and 236 were re-tested as controls. The frequency and severity of daily hassles were associated with symptom severity. Alertness was reduced and simple reaction time was slower in the URTIs group and the high stress/ill group showed the biggest impairments. These effects remained significant when health related behaviours and personality were covaried. The difference between the high and low stress URTI groups did not reflect symptom severity.
Interpretation: The behavioural impairments induced by the common cold are greater when the person has been exposed to stressful events.

1. Introduction

Early studies of naturally occurring upper respiratory tract illnesses (URTIs) demonstrated associations between stress and illness (see Cohen and Williamson, 1991; Pedersen et al.,

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http://dx.doi.org/10.1016/j.psyneuen.2013.03.012

2010 for reviews). Many of the methodological weaknesses of this early research were overcome in prospective studies investigating associations between daily hassles and subsequent illness (e.g. Stone et al., 1987). Studies of experimentally induced colds (e.g. Cohen et al., 1991; Cohen, 2005) have furthered our knowledge of this topic and shown that negative life events are related to susceptibility to illness (Cohen et al., 1993a). The research on this topic has also shown that it is essential to adjust for the influence of possible confounders (e.g. health-related behaviours — Cohen et al., 1993b; personality — Cohen et al., 1995; and demographics).

Another line of research has examined the behavioural consequences of having an URTI. This research started with studies of experimentally induced colds and influenza (see Smith, 1990, 2012a for reviews) but has been extended to consider naturally occurring illnesses (Smith et al., 1993a, 1998). The main findings have been reviewed elsewhere (Smith, 2012a) and they can be summarized as follows. When a person has an URTI they report reduced alertness and show impaired speed of responding and slower encoding of new information (Smith, 2012b). This has important practical implications and recent research has demonstrated that when a young adult has a cold they perform at the level of a 65 year old person and show impaired performance on simulated driving (Smith and Jamson, 2012). It has been suggested that the malaise induced by a cold reflects the reduced turnover of central noradrenaline (Smith et al., 1999). Noradrenaline is also important in determining the response to stress and it has been shown that when a person has an URTI they are more susceptible to noise (Smith et al., 1993b) and to fatigue (Smith et al., 2004). In these studies the noise and the fatigue had little effect on the healthy individuals and one is dealing with "moderation" rather "mediation" (Baron and Kenny, 1986). These studies examined acute stress and it is now important to determine whether those with an URTI and exposed to chronic stress show greater impairments than individuals without an illness or those who are ill and have low levels of stress. The present study is the first to integrate these two approaches to examine whether the combination of being ill and having been exposed to chronic stress is associated with the greatest behavioural impairment. Other research has shown that when a person has an URTI they are more sensitive to the acute effects of a low dose of alcohol (Smith et al., 1995a), with alcohol having no effect on those without a cold but leading to a large slowing of reaction time in those who were ill. Regular levels of alcohol consumption and chronic stress may alter subjective mood and objective measures of performance (Smith et al., 1995b) and the present study examined whether these effects were more apparent when the person is ill. The literature also suggests that the effects of major negative life events on health differ from those of daily hassles, with negative health outcomes showing a stronger association with hassles than life events (e.g. DeLongis et al., 1982; Jandorf et al., 1986). This issue was also addressed here. When a person has an URTI their ratings of alertness are correlated with symptom severity (Smith, 2012b). In contrast, the effects of having a cold on psychomotor speed are independent of symptom severity and the use here of both subjective ratings of alertness and an objective measure of simple reaction time allows one to consider outcomes reflecting different effects of the illnesses. Ratings of alertness have been widely used in studies of URTIs (see Smith, 2012a). As well as being used in studies of URTIs, the variable fore-period simple reaction time task, often referred to as the psychomotor vigilance task (PVT) has become the gold-standard for assessing low alertness states such as sleep deprivation (Lim and Dinges, 2010).

The aim of the present study was to examine possible interactions between URTIs and chronic stress. This was done using a well established methodology (see Smith, 1990, 2012a for reviews) for examining behavioural effects of URTIs (a prospective design with validated definitions of URTIs; established symptom checklists and objective signs of URTIs). This was combined with established measures of chronic stress (life events and daily hassles) and control of relevant confounding variables (e.g. personality and health-related behaviours). The analysis strategy was based on the above studies which examined the combination of illness and acute changes in state (induced by noise, workload and alcohol). Measures of both subjective alertness and objective reaction time were included. These are both influenced by URTIs but reflect different aspects of malaise. For example, subjective mood is highly correlated with symptoms whereas reaction time changes are largely independent.

2. Methods

2.1. Ethical approval

The study was carried out with the approval of the School of Psychology, Cardiff University, ethics committee, and the informed consent of the volunteers. All included participants were required to sign a consent form outlining the experiment, explaining that they were free to withdraw at any time and confirmed the confidentiality of all information. Participants were paid £20.00 on completion of the study.

2.2. Experimental design

A between subjects, prospective design was employed (see Fig. 1). A cohort of participants was recruited when free from

Time	Measures taken
Recruitment	Informed consent Exclusion criteria (existing illness; medication) Familiarization with testing procedures
Baseline	Questionnaire measuring health-related behaviours, personality, and negative life events. Rating of alertness. Variable fore-period simple reaction time task.
Second session Either: when participant developed an URTI, Or for controls, 12 weeks after baseline	Check on exclusion criteria (length of illness; use of medication; caffeinated beverages). Symptom checklist. Sub-lingual temperature. Nasal secretion. Daily hassles. Alertness. Variable fore-period simple reaction time task.

Figure 1 Design of study.