PATTERNS OF PSYCHOLOGICAL RESPONSE TO THE DEMANDS OF COMPUTER-SUPPORTED WORK

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SUMMARY

The central aim of the thesis is to examine and resolve some of the fundamental theoretical and methodological problems in stress research. Two interdependent means of realising this aim are adopted. The first involves a critical analysis of research practices, the building of a theoretical framework, and the development of methodologies. The second assesses these methodologies by using them to explore affect and symptom reporting in computer-supported work.

In order to perform a critical analysis of stress research the key variables are reviewed. Methodological problems encountered in the measurement of each variable are examined, and theory implicit in their measurement is discussed. Existing explicit theories of stress are considered and found to be inadequate. A rational approach to theory building, which takes account of the complexity of stress phenomena is adopted. A theoretical framework of Adaptive Action Control is presented, synthesized from a number of theories, including action theory and motivational control theory. The meaning and measurement of variables within this framework is discussed.

Three empirical studies are reported, and their results considered both in terms of their research findings, and wider implications for methodology. The first study is exploratory, using cross-sectional questionnaire methodology typical of much stress research. Several variables were found to be associated with symptom reporting, but the nature of these methodologies make interpretation of the results difficult. In contrast, the next two studies use theory-based diary methodologies and measures of hassles and affect. Different patterns of associations between variables were found for different dimensions of affect and types of hassles. Few effects of computer use were found. The diary methodologies were shown to be useful, and provided indirect support for the theoretical framework. Future development of the framework and its implications for stress research and the relationships between theory and methodology are discussed.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

The main concern of this thesis is the examination of some fundamental theoretical and methodological issues in stress research. This examination is carried out in two interdependent ways. The first involves a critical assessment of issues in stress research and the development of theory and methodology. The second uses these methodologies to empirically investigate a specific research topic in occupational stress, namely psychological stress in computer-supported work.

This chapter describes and discusses the rationale, the aims, the general approach adopted in the thesis, and the historical background to stress research. The rationale and aims are expressed in quite broad terms, and details of the subject matter of the thesis are discussed in subsequent chapters. Four different research areas in which the stress concept developed are described in the historical background. This is followed by a summary of more recent developments in stress research. This history provides some reasons for the theoretical orientation of this thesis, and a context for the later development of theory.

1.1 Rationale and aims of the thesis

The rationale of each of these types of examination, and the corresponding aims of the thesis will be dealt with briefly in this introductory chapter. A comprehensive and detailed discussion of these issues will take place in Chapters Two and Three.

1.1.1 Issues in stress research

The focus of this thesis is the development of theory and methodology. While such a focus would doubtless make a contribution in many areas of psychological research, stress research in particular has a deficiency of strong and unified theory and methodology.

The most damaging consequence of this deficiency is that it places a constraint on efforts to understand problems of both a pure scientific and applied nature. Such constraint occurs not only in the conduct of research (the use of measures, the design of studies and so on), but also limits the generalizability and integration of findings.

There is, therefore, a strong need for research which is based on a thorough examination of these fundamental theoretical difficulties. The subsequent refinement of theory must go hand-in-hand with the development of methodology for testing and refining such theory. In this way, constraints placed on previous research may be avoided. Such an approach is unlikely to yield easy solutions to such fundamental difficulties, but will at least provide ways of asking more direct and more answerable questions.

This methodology can only be assessed by its use in empirical research. The following section, which forms the second part of the rationale, will discuss the needs of the research area in which this methodology will be applied.

1.1.2 Research into stress in computer-supported work

Despite the widespread use of computers at work for many years, the topic of stress in computer-supported work remains largely unexplored. Where it has been explored, the main concern has been the effects of Visual Display Units

(VDUs) on the health of those whose work is often repetitive and involves the intensive use of computers (see Elias et al, 1983; Howarth & Istance, 1985; Smith et al, 1981).

This focus has two limitations. First, a physical rather than a psychological notion of stress is adopted in which the VDU is seen to have directly harmful effects on the user, and other influences on health and symptom reporting apart from the use of a VDU tend not to be taken into account. Second, such intensive computer usage is not typical of the broad range of work involving computers.

The few studies which have instead focused on psychological stress are largely concerned with the question of whether the transition from traditional to computer-based technologies leads to an increase or reduction in stress. This narrow focus is often at the expense of other questions which could be asked about the nature or the form of relationships between technologies and stress, as opposed to the degree of stress involved in working with computer-based technologies.

The empirical work, in addition to addressing these research problems, will be used to assess new methodologies in stress research. The area of computer-supported work is a suitable vehicle for assessments of such methodologies as the type of research problems encountered whenever attempts are made to assess the psychological effects of technology at work are also found in stress research where the psychological effects of environmental change are assessed. A common difficulty is the problem of separating the direct influence of the technology or the environmental change from the indirect influences.

1.1.3 Aims of the thesis

The general aim of this thesis is to advance our understanding of some important issues in stress research. The specific aims can be described on three interdependent and partially overlapping levels; theoretical, methodological and empirical. Figure 1.1 below gives examples of aims and questions which can be specified on each of these levels.

Figure 1.1 The theoretical, methodological and empirical levels of research with examples of aims and questions which can be specified at each level.

THEORETICAL LEVEL

Aims	Questions
To critically review and evaluate existing theories	Which phenomena are these theories attempting to explain?

METHODOLOGICAL LEVEL

Aims	Questions
To assess the specific effects of work demands and their intraindividual fluctuations	How can affect and symptoms be measured in detail on a daily basis?

EMPIRICAL LEVEL

Aims	Questions
To examine the relationships between daily affect and other variables	Under what circumstances do daily hassles influence levels of affect?

Answers to questions on one level should inform the aims and questions which are generated on the level below, which in turn should feedback to the aims and questions above.

To achieve the general aim of this thesis on the theoretical level, the three specific aims are as follows: First, to critically review existing theories of stress. Second, to produce a framework which attempts to integrate these theories. Third, using this framework and theories from other areas, to refine existing theories and/or develop new theories which advance our understanding of stress.

On the methodological level, the specific aim will be to design studies and develop measures which arise from and are based on this theoretical framework, and which are capable of examining stress in computer-supported work.

On the empirical level, there are two specific aims: First, to examine the nature and extent of stress in computer-supported work; and second, to evaluate the design of the studies and measures in the context of the theoretical framework. This evaluation is then fed back into the theoretical and methodological levels.

Previous stress research has often failed to adopt such an approach, so producing many studies which are weak on one (or sometimes two) of these levels. For example, a study may be strong on a theoretical and methodological level, but fails on the empirical level perhaps in the application of methodology, or by not paying sufficient attention to results. The use of this restricted approach produces individual studies which are unsatisfactory, and confounds the issues in stress research mentioned above.

The broader approach taken in this thesis takes account of this interdependence in order to guide the conduct of research, and to identify the causes of and solutions to research problems. Without such an approach, an integration of the specific and general aims would be difficult to achieve.

1.2 Questions asked in the thesis

Not all the aims of a piece of research can easily be converted into questions. Some questions may arise as the research is being conducted, or be so indirectly related to the broader aims that they are difficult to specify at a planning stage. In this section, the types of questions which be can be specified at this stage will be described. The purpose of this is twofold; first, to give a general indication of how the research will be conducted, and second, to define its scope.

The specific aims of the thesis were specified on three interdependent levels; theoretical, methodological and empirical. These same categories will be used to describe the types of questions to be asked. The interdependency of these levels means that the answer to some questions asked on one particular level may be found on one or two of the other levels. For example, in order to answer a methodological question it may be necessary to examine both the theoretical and empirical issues associated with that question. The following sections therefore specify the levels on which the questions are asked, and not necessarily the level on which they will be answered.

1.2.1 Theoretical questions

Given the general aim of the thesis, these questions are of primary importance. They can be divided into two main areas: Questions which critically address theoretical difficulties in past and present stress research, and questions which are aimed at refining or developing usable theory.

The first area is the starting point for this thesis. Although questions that critically address theoretical difficulties are numerous, they can be placed in three categories: Those which are asked in order to identify these difficulties; those which ask about their effects; and those which ask about their causes. Such questions are by their nature broad, and their answers diffuse. Many perspectives can be taken to ask and answer questions about theoretical difficulties. A historical perspective, for example, may make the causes of these difficulties clearer through a careful examination of the development of particular lines of research, or the activities of individual researchers or groups of researchers. To give another example, a philosophical perspective might give some insight into the conceptual foundations of stress research. Concepts and ideas taken from biology, medicine, engineering, sociology, psychiatry, other areas of psychology, and models of scientific theory and practice taken from pure science, have all played their part in shaping stress research. An insight into such influences may provide some answers to theoretical questions.

As the aims of the thesis go beyond a purely historical or philosophical account of difficulties in stress research, it is essential that the scope of such questions is actively limited. This is achieved here by asking theoretical questions which address the refinement or development of usable theory. The scope of questions from this first area can therefore be actively limited by asking and answering them only when they can be seen to contribute to the refinement or development of usable theory. Such a strategy must be seen as procedural. Its purpose is to ensure that the questions asked produce answers which facilitate the next area of questioning, and in addition help to maintain the balance and interdependency of the theoretical, methodological and empirical levels of inquiry.

The term 'usable' in relation to theory can have a number of meanings. What is usable theory to one person may not be to another. Sometimes this difference of opinion results from the context of a particular piece of research, or the constraints placed upon it. If quick answers are required to relatively easy and specifiable questions there may be no time, or indeed any need to use well-founded and strong theory. In this case, any theory, idea, or descriptive framework adopted by the researcher may be perfectly usable to them, but may be seen by others to be unusable as it does not have the depth or breadth to explain very much beyond the quick answers to the easy questions. This difference can sometimes be observed between pure and applied research, where the context in which each is being conducted imposes a different notion of what constitutes a usable theory. There are also context-free reasons for the differences in opinion about what constitutes a usable theory. These differences would seem to revolve around the question of what, in general terms, a theory is for and what it can or should do, and how research should be conducted. Given the general aim of this thesis, usable theory is any theory which helps in the analysis of theoretical and methodological difficulties in stress research.

The second area, the refinement or development of theory, attempts a synthesis rather than an analysis. Two general questions will be asked. First, how can theories of stress be integrated in a meaningful way? Second, how can this integration lead to the development or refinement of usable theory?

Both types of question are required as one of the problems in stress research is not so much a lack of theory, but the absence of a framework for integrating different and sometimes opposing theories. It may be that an existing theory, once integrated with others and refined may prove to be a usable theory. On the other hand, existing theories may be inadequate for this task, and new theory may have to be developed.

Before moving on to the next level, a further question will have to be asked, though it cannot easily be described on any of the three levels. It is likely that any theory which is integrative, and then refined or developed will be very large and hence difficult to fully test and use within the limits of a thesis. Therefore, the following question will have to be asked: Which parts of the theory are tested and used in this thesis, and which omitted? The answer may be partly theoretical and partly pragmatic, but will probably be found by considering the topic which will act as a vehicle for the assessment of the theory and accompanying methodology, psychological stress in computer-supported work.

1.2.2 Methodological questions

The most general question is how can methodologies be developed which evaluate the theory from which they are derived while taking account of the particular topic under examination? The two parts of this question, evaluation, and the particular topic under examination, act to shape and constrain the questions which can be asked, and the answers which can be given.

Bearing in mind these two aspects of the general methodological question, on a more specific level, methodological questions can be described in three areas. First, there are questions about subjects or participants; second, questions about instruments or measures; and third, questions about the design and procedure. In all of these areas, theoretical and specific practical issues will influence the questions which can be asked, and the methodologies which will be used. However, given the general aim of this thesis, it is important that practical issues do not dominate the theoretical issues. Methodologies could be developed which would be very suitable for the examination of stress in computer-supported work, but which do not reflect or represent the theory, and therefore could not be used to evaluate the theory.

Once equipped with theory and methodology, a further influence on the methodological questions asked will be the particular empirical questions asked and answered using the theory and methodology.

1.2.3 Empirical questions

These fall into two areas. Those which assess the nature and extent of stress in computer-supported work and those which evaluate the methodology and the theory. The questions asked to assess the nature and extent of stress in computer-supported work will largely be determined by the theory and methodology used. As the theory and methodology have not yet been developed, it is difficult to describe at this stage the questions in this area. However, as discussed earlier the research will attempt to overcome some of the shortcomings of previous research. The questions asked here therefore will examine the relative importance of computer usage as a feature of stress at work, and where relationships are found, the nature of those relationships, such as direct and indirect effects, will be explored.

Some of the empirical questions which evaluate theory and methodology are not connected with the studies which will be conducted in this thesis in that they do not appeal to numerical data as the final arbiter of the truth or accuracy of a theory. Questions which are aimed at a non-empirical evaluation of the theory (described in section 1.2.1 above) may actually be empirical in the sense that they appeal to data such as the experiences and observations of the researcher, or the views and theories expressed in other research, but they may also take a comprehensive non-empirical (or rational) approach to evaluation by appealing to argument and reasoning by examining the internal consistency and coherence for example. In contrast, a purely empirical and quantitative evaluation of theory requires that a theory should be able to predict or explain the association between events or phenomena from which data are created by systematically giving numerical values to the phenomena. Empirical questions concerned with this type of evaluation lead directly to hypotheses. As discussed earlier, it is likely that any theory which is developed or refined will be broad and complex. Specific hypotheses can usually only be generated from relatively small parts of a large theory. The evaluation, therefore, of a large theory requires that a great many small hypotheses are tested, although each particular small result may support or cast doubt upon the validity of a large theory. The empirical questions asked here will evaluate, rather than test specific parts of a more general theory. Their answers and in particular the interpretation and analysis of their answers, will be used in a broad sense to evaluate the general theory.

Questions asked about the empirical evaluation of methodology, while closely linked with the evaluation of theory are quite different. These can be described simply as they focus on a central question: Are the methodologies usable, reliable and valid? This question can be asked in an intrinsic, technical way, referring to measurement and statistical issues. In can also be asked in a less technical way, by considering issues such as face validity, and the usability of the methodologies as judged by the researcher and the researched. All the empirical questions asked will in one way or another evaluate theory and methodology, although substantive questions will be asked about the nature and extent of stress in computer-supported work. While it is only possible to test specific parts of the general theory, a further and crucial part of the evaluation will ask if the general theory can, as a broad framework, aid the interpretation of the results and findings of the empirical work.

1.3 Background to stress research

So far, the terms 'stress' and the term 'stress research' have been deliberately used in a general way to include occupational stress, computer stress, and any other kind of stress. There is no clear requirement to distinguish between stress in the experimental setting, stress in or out of work, stress experienced while using a computer, or stress in the community. The term 'stress' itself has also deliberately not been defined, nor has a discussion of definitions taken place. In this section, in order to introduce the subject of this thesis, a historical approach will be taken to definitions of stress, and to understanding the current characteristics of stress research.

1.3.1 Historical background

How did contemporary stress research evolve? Even a cursory historical examination of the literature reveals the complexity of this question, and diversity of the possible answers. At the root of this complexity are problems with defining stress, and the ways in which different definitions and conceptualizations have developed and interacted over approximately the last fifty years.

The definition of stress has proved to be a constant source of controversy and debate:

> If the word "stress" is to enter the language of biological science, responsibilities concerning its meaning are entailed. (Wolff, 1953, p. v)
>
> There exists a widespread inconsistency in defining stress, together with an inadequate concern for meaning. (Haward, 1960, p. 185)
>
> I find it difficult to express my surprise and horror that contemporary science should tolerate this confusion between stimulus and response. (Pickering, 1961, p. 116)
>
> Perhaps the single most remarkable historical fact concerning the term "stress" is its persistent, widespread usage in biology and medicine in spite of almost chaotic disagreement over its definition. (Mason, 1975, p. 6)
>
> There are so many uses of "stress" that it may be more confusing than anything else. (Fleming et al, 1984, p. 939)
>
> Certainly, 'stress' is a term beset with conceptual confusion...If we do not know exactly what is meant by the term 'stress', resulting problems with construct validity will hinder the construction of measures, and weaken the validity of conclusions drawn in studies employing such measures. (Pratt and Barling, 1988, p. 42)

As illustrated by these quotations, problems with the definition and conceptualization of stress have been apparent for decades. Some view these problems as the consequence of weakly conceptualized, unprogressive research, while others have viewed such problems as the cause. While both these arguments have some validity, there are also causes of definitional and conceptual problems which have little to do with the conduct of research, and more to do with the development of different definitions and conceptualizations during the continuing evolution of stress research.

The concept of stress is broad, ranging, for example, from physiological to psychological phenomena. As a result, its origins are quite diverse yet interconnected. A discussion of even most of these origins is quite beyond the scope of this thesis. However, by taking the discussion from approximately the 1930s, (where the term stress was first used in a medical research context and gained some popular appeal) to the early 1960s, (which marked the start of the contemporary period of psychological stress research) the origins can be clearly located in four main areas. Each of these will be briefly discussed in turn.

Stress as a biological/physiological phenomenon

This first and oldest area has its origins in the work of Claude Bernard and Walter Cannon, who attempted to make links between specific physiological processes and much broader biological theories. In the later work of Hans Selye (who is mainly responsible for the widespread use of the term 'stress' today and its initial use in medical research) attempts to relate physiology to biological functioning are also found.

Claude Bernard made two observations which were crucial to the development of the idea of stress as a biological/physiological phenomenon. First, he observed that a distinction could be made between the internal and external environments of an organism. Second, he argued that organisms functioned so as to keep the internal environment in a relatively steady state.

> All the vital mechanisms, varied as they are, have only one object, that of preserving constant the conditions of life in the internal environment. (Claude Bernard, quoted in Olmsted (1939), p. 287-288)

It is widely accepted (e.g. Blundell, 1975; Carlson, 1981) that it was the work of Bernard which led Walter Cannon to develop the idea of homeostasis as the relatively steady states of internal environments (Cannon, 1939).

Cannon (1935) was also concerned with stimuli which had potential to alter the internal environment, and the mechanisms (such as fight or flight), which attempted to preserve homeostasis. Interestingly he called such stimuli "stresses" (p. 7), and included heat, cold, and emotional stimuli among them. If such stresses became excessive, that is the point at which stability of the steady state becomes significantly altered, he described these stresses as having induced a "breaking strain" (p. 7) in protective homeostatic mechanisms. He goes on to define the term 'significantly altered' as "where the alteration becomes so great as to cause secondary, irrelevant effects" (p. 7). Cannon's use of the terms stress and strain are broadly similar to an engineering analogy applied to the steady state. Stress is a force acting upon, and strain the resulting change (deformation) in the steady state.

As stated above, it was Hans Selye who was largely responsible for the popularization of the term stress. In a letter (Selye, 1936) published in *Nature* he reported "A syndrome produced by diverse nocuous agents", which consisted of three stages. Selye discovered this syndrome by observing physical damage in the internal organs of rats, after exposure to a range of acute nocuous stimuli such as cold, excessive physical exercise, and large doses of drugs. The first stage of this syndrome was essentially Cannon's fight or flight response, and like Cannon, the main focus of interest was not in the nocuous agents, but in the internal physiological responses to such agents. Later, based on further experiments into the General Adaptation Syndrome (as he came to call it), Selye (1956) defined stress as "the common denominator of all adaptive reactions in the body" (p. 54). In other words, stress is a non-specific response: While each particular stressor (stimulus) produces a unique response in an organism, each response also has certain common, or non-specific elements.

Selye (1956) reported that initially (around the time of the publication of his letter) he experienced such "violently adverse public opinion" (p. 30) to his use of the term 'stress' that he stopped using it for several years. It was suggested at the time that the term was too similar and would be easily confused with popular, non-technical words such as nervous strain.

In this area, stress is viewed as an essentially physiological phenomenon. While Cannon used the term stress fairly broadly to mean a stimulus or force, Selye was "inclined towards defining "stress" variously in terms of either a stimulus, response, or interaction between stimulus and response" (Mason, 1975, p. 9). Despite such differences, the focus of this conception of stress is still on internal physiological activity, which is regulated by internal physiological mechanisms.

Stress as an inhibitor or disruptor of performance

In the second historical area of stress research, stress is viewed as some form of inhibitor or disruptor of performance. In contrast to the first area it was less influenced by the work of particular individuals, evolving from an applied research problem, and later developing into an important area of experimental psychology.

The applied research problem was essentially a military one. Expressed simply, military authorities were keen to predict when a soldier would become incapable of functioning psychologically during battle conditions (e.g. Bartlett, 1927). While an interest in such extreme problems has according to Appley and Trumbull (1986) occasionally resurfaced, this initial problem led to a great deal of experimental work designed to assess the effects of 'stress' not on complete mental collapse, but on performance.

For example Freeman (1945) who developed the "Standardised Stress Test" (p. 3), which was to be used to predict "combat flight success" (p. 11), used the term 'stress' to mean a distraction, or extra demands for attention. The relationship between 'stress' and performance also had implications for the discipline of Human Factors, and was seen to be of "considerable theoretical importance" (Lazarus and Eriksen, 1952, p. 100).

Within this area, stress became any stimulus or situation created in an experimental setting which had a negative effect on, or disrupted skilled performance. Here too, problems in definition were apparent. In a review, Pronko and Leith (1956, p. 205) note that the term 'stress' had been used to refer to behaviour, to a stimulus, or to a situation. In addition, they note that

> The recent profusion of experiments on "stress" have a striking novelty about them. They almost suggest that a new behaviour has been discovered in the psychological laboratory. Indeed one searches in vain for "stress" in issues of Psychological Abstracts of 20 years or so ago.

'Stress', despite being a relative newcomer to psychological terminology, was already suffering from problems of definition, though its interpretation as a performance disruptor or inhibitor was clear.

Stress as a factor in the development of illness and symptoms

The work of Cannon (1935) and Selye (1956) had a profound influence on medicine (Mason, 1975), and while their work influenced the study of stress as a causative factor in the development of illness and symptoms, it also has traditions and origins of its own. The idea that psychological and emotional factors may play a role in physical illness is certainly not a new one (Lipowski, 1984). Two main methodological approaches can be distinguished in this area, which started in the 1940s and 1950s.

The first approach tended to focus on psychosomatic processes in the individual. The orientation was psychophysiological rather than psychoanalytic (Wittkower, 1977). In other words the cause of illness was not seen to be, in psychoanalytic terms, conversion hysteria (which is understood through the symbolic meaning of bodily changes, Nemiah, 1977), but was explained by the physiological changes which accompanied emotional reactions. An example of this approach is provided by Wolff's classic observations (e.g. Wolff et al, 1948) of short-term changes in various mucous membranes in human subjects during 'stress'. Stress was characterized by emotional conflicts such as "anxiety, resentment, anger, fear, and frustration" (Wolff et al, 1948, p. 313). Wolff discussed various topics with the subjects (some of them clearly distressing) and observed changes in mucous membranes, such as the stomach lining and concluded that "such changes are pertinent to an understanding of symptoms and disease" (Wolff et al, 1948, p. 333). Wolff (1953) defined stress as "the interaction between external environment and the organism, with the past experience of the organism as a major factor" (p. v).

The epidemiological approach to the role of stress in the development of illness, while perhaps sharing a definition of stress with the first approach described above, was more concerned with environmental or life 'stress' than individual or interactional processes. For example Halliday (1948) took a cultural, anthropological, and epidemiological approach, in which quite broad sociocultural changes were seen to have an effect on the incidence of disease.

Because of their different methodologies, the two approaches, although they share a view of 'stress' as a psychophysiological cause of illness, differ in their focus. For the first, the focus is clearly on individual psychophysiological responses to threatening emotions, such as anxiety, produced by psychological conflict. For the second, on the other hand, environmental or situational factors are assumed to be operating though individual responses.

Stress as an antecedent of psychological adaptation

Early psychoanalytic thought, while rejected by many of those working in psychosomatic medicine, was extremely influential in the development of this fourth historical area, the idea of stress as an antecedent to adaptive psychological processes. The interest here was not in the role of threat or psychological conflict in the development of illness, but in the processing of the threat itself.

Threat and anxiety were key components of Freud's "dynamic conception of mental life" (Freud, 1943, p. 53). However, in Freud's earlier work there was little interest in 'objective' anxiety, and the function of the ego in regulating such anxiety (Janis, 1958). Such ordinary, 'everyday' anxiety was perhaps too intelligible and too simple for Freud, whose view was that ego "seemed to need so little explanation" (Freud, 1946, p. 79).

It was from a desire to understand the total (as opposed to the abnormal, intrapsychic, and unconscious) personality that ego-psychologists such as Hartman (1958) and Menninger (1954a; 1954b) broke away from traditional psychoanalytic thinking. They considered how people coped with or adapted to real tensions. It was argued that any theory of personality would be incomplete if it could not explain the adaptive responses made to both external, rational threats, and intrapsychic symbolic threats (Janis, 1958). The role of the ego is expressed by Menninger (1954a) in the following passage:

> The world moves, and all things change constantly. The ego has, therefore, no rest; it is continuously "under fire" in its reconciliatory function. It is under pressure from instinctual urges, from somatic needs, and from environmental offers, demands, and threats. It must bring peace. Peace does not mean the quelling of all demands, but the achievement of optimum tension through the arrangement of the least expensive compromises. (p. 85)

A wide range of situations were studied by ego psychologists. Janis (1958) for example, studied psychological reactions in surgical patients, and considered impending surgery to be a severe stress situation. Speisman et al (1964) used film as a stimulus to experimentally study responses to, and interpretations of threat.

Ego psychologists were implicitly and explicitly using the concept of homeostasis (as discussed above), but applying it to the internal psychological rather than the physiological environment. Menninger (1954b) wrote that:

> the principle of homeostasis or steady state maintenance can be applied to psychological phenomena and psychoanalytic theory. The functions of the ego in receiving external and internal stimuli and in dealing with them for the best interests of the organism can be viewed as a homeostatic effector. (p. 308).

Menninger (1954b) placed the regulatory devices of the ego into five hierarchical categories, distinguishing between normal or healthy devices used in response to minor stresses, and those used in response to greater or more prolonged stress.

The early work of such ego psychologists, along with experimental animal research, formed the basis of modern concepts of coping (Lazarus and

Folkman, 1984). Within this area, the term 'stress' was used in different ways. Janis (1958) used it to refer to both stimuli or the situation, and to responses or reactions. Menninger (1954b) while not defining the term stress clearly, probably intended it to mean a stimulus, or a situation. While definitions were inconsistent, the role of 'stress' as a precursor of psychological adaptation, or coping, is clear.

Summary

Each of these four areas in which the concept of stress has evolved have a number of common features. Each area has encountered similar problems with definition: Is stress to be defined or conceptualized as a stimulus, a response, a situation, or some form of interaction?

Although each area emerged from the different disciplines of physiology, psychology, medicine, and psychoanalysis, the concept of stress has served a similar function within each of these areas. By considering these disciplines as essentially engaged in the study different systems, it is clear that the concept of stress, irrespective of how it is specifically used, provides a framework for examining the adaptive nature of such systems. (Perhaps this partly explains why the concept of stress did not need to be defined clearly.) For example, one discipline may involve attempting to understand how organisms adapt to physiological changes, while another how people engaged in performing a task adapt to disruptive conditions. A related point is that much of the research in these areas concentrated on extreme situations (such as impending surgery, intoxication with drugs) in which adaptive mechanisms actually failed, or almost failed to maintain equilibria in their respective systems.

It was mutually assumed that because these areas were using similar terms such as stress, or strain, that they may be researching into the same phenomenon, but from different scientific perspectives. Janis (1958) urged caution in the use of the term stress:

> Several writers...have attempted to define it in terms of "homeostasis," with the intention of using the same vocabulary as that of Selye...and other biological scientists who have developed the concept of "physiological stress." A number of psychologists however take the position that the physiological term does not necessarily refer to the same type of phenomena as the psychological one, and that it is premature to attempt to integrate the two concepts. (p. 12)

Despite these warnings, such problems were to reappear. A conference titled "The Crisis in Stress Research: A Critical Reappraisal", held in 1977, was reported in *The Journal of Human Stress*. In the Call to the Conference (1979), the authors, commenting on the state of stress research, noted that "researchers... were, in fact, often assuming that the concept of stress advocated by Hans Selye, which was based on a physiological response pattern, was related to the psychological assessments they were making" (p. 5). In general then, these areas tended to assume similarity and interrelationships between phenomena, simply because they have the same name, or are based on the same model of processes (e.g. homeostasis). This assumption has continued to the present day.

The historical background to stress research shows two main facets. The first is problems in definition. The second is the diverse origins of the contemporary concept of stress. What is perhaps most striking about these different areas is their similarity. By considering definitional problems, and assumptions about interrelatedness of the stress concept, we can observe similar patterns in each area. It will be demonstrated, in the next chapter and others, that an appreciation of the historical background is vital for understanding contemporary stress research, and its current difficulties.

1.3.2 More recent historical background

The previous section discussed four areas in which the use of the term and the concept of stress evolved. For the sake of clarity and conciseness, this discussion was limited to a particular historical period, and to those areas of research which simply used the term stress. Most of the difficulties which were experienced by stress researchers in each of these different areas are still being experienced today. The evolution of stress research seems to have proceeded in a linear and slow fashion. Problems with defining and conceptualizing stress, remain a major feature of stress research.

This evolution has however changed course slightly in that interest in stress as a physiological concept has declined whereas research and interest into stress as a psychological concept, or as a factor in disease has increased (Mason, 1975). As discussed in the previous section, researchers in different areas of stress research have tended to assume some common ground; that all 'stress' is part of the same phenomenon. The lessening of interest in physiological stress has made such assumptions easier to make, as there are fewer research programmes designed to explore such links. It would appear that psychologists are very willing to associate Hans Selye's concept of stress with the concepts they are using. For example, Selye has written a number of introductory chapters in books about psychological stress (Selye, 1980, 1982, 1983).

This more recent history reveals a continuation of conceptual and definitional problems, and a discontinuation in some of these early lines of research. Despite a lack of integrating knowledge, implicit assumptions are made about the interrelatedness of the various psychological and physiological conceptualizations of stress, which developed for different reasons, and in distinct ways.

1.4 Structure of the thesis

The above introduction has emphasised theoretical and methodological issues in stress research. In addition, emphasis has been given to the application of theoretical and methodological developments by using them in the empirical investigation of stress in computer-supported work.

These two points provide a clear structure to the thesis by means of a division between the development of theoretical and methodological issues, and the use of such developments in empirical investigations. While specific theoretical and methodological issues will continue to be developed during the course of the empirical investigations of stress in computer-supported work, such specific developments can be distinguished from the discussion of general developments in methodology or theory, which will take place before and after the reports of the studies.

The thesis is divided into three parts which can be viewed as stages in a process, moving towards meeting the aims described in the rationale. The first part, containing Chapters Two and Three, will discuss and development of theory and methodology. Chapter Two will contain a critical review of the key variables measured and used in stress research. Chapter Three will focus first on the implicit and explicit theoretical relationships between these variables, and will then develop theory to provide a framework for understanding theories of stress, and to provide theoretical and methodological guidance to the empirical studies.

The second part will report the three empirical studies in Chapters Four to Six. Each of these Chapters will discuss the results of the each study in two ways. First, the findings which specifically relate to the research topic of stress in computer-supported work will be discussed. Second, the implications of the findings for the methodology and the theory from which they were derived will be discussed. Chapter Four reports the results of an exploratory cross-sectional study whose main aim is to establish the general determinants of symptom reporting in computer-supported work using conventional methodologies. Chapters Five and Six use theoretically derived methodologies based on the use of diaries completed repeatedly over periods of work sessions and days.

Chapter Seven, which is the third part of the thesis is a general discussion and conclusion of the whole thesis. First, the nature of stress in computer-supported work is discussed in terms of the results all three studies. The implications for future development of these methodologies, and the theoretical framework are discussed. This chapter and the thesis is concluded by a consideration of the future of stress research.

1.5 Summary

This chapter includes a description and discussion of the rationale, the aims, the general approach adopted in the thesis, and the historical background to stress research.

The main concern of the thesis is the examination in two interdependent ways of some fundamental theoretical and methodological issues in stress research.

The first type of examination involves a critical appraisal and synthesis of theory and methodology. The second type of examination involves the application of this theory and methodology in empirical practice though the study of stress in computer-supported work.

A deficiency of strong theory or methodology, which has constrained our efforts to understand stress provides the main rationale for the focus of this thesis. The choice of stress in computer-supported work as the topic for research is made partly because of the lack of research in this area, and also because some of the methodological difficulties encountered in assessing the effects of new technology are shared by stress research as a whole. This topic is a suitable vehicle in which to assess developments in methodology.

The general aim of the thesis, which is to advance our understanding of some important issues in stress research, can be specified on three levels: The theoretical, the methodological and the empirical. Aims described on each of these levels will be used to maintain the balance and interdependency of these different levels. One of the problems in much stress research is the failure to ask interdependent research questions on each of these levels.

On the theoretical level, two main types of questions can be identified: Those which critically address theoretical difficulties in past and present stress research, and questions which are aimed at refining or developing usable theory. Methodological questions fall into two categories: Those which ask how methodologies can be developed, or used, which test the theory, or parts of the theory, and those which ask if the methodologies are suitable for the particular topic under examination. The two types of empirical questions which can be asked are those which are asked in order to assess the nature and extent of stress in computer-suppported work, and those which are asked to test and evaluate the theory and the methodology.

In order to provide a context for the questions asked in the thesis, it is important to first consider the historical background to stress research, which is very broad, complicated, and diverse. Two aspects of this history, confusion and debate over definitions and conceptualizations of stress, and the partly overlapping evolution of different strands of stress research, account for this diversity. More recent history shows that many of these early problems are as apparent now as they were then.

PART ONE

Part One of this thesis contains Chapters Two and Three. Chapter Two discusses the key variables in stress research in terms of their history, conceptual and methodological development, and their current status. In this chapter, the stress phenomena is broken down into its component parts and analysed by subjecting these variables, as components of the phenomena, to close scrutiny. No explicit references to theory are made, so that a distinction is maintained between the components of phenomena discussed in Chapter Two, and the theories which attempt to explain how these components interact which are discussed in the following chapter.

In Chapter Three the implicit and explicit theories of stress phenomena are discussed and reviewed. The central criticism of these theories is that they are narrow, simplistic, and misrepresent the phenomena they attempt to explain. A rational approach to theory building is adopted, in which general principles and argument, rather than empirical observation, are used to develop a theoretical framework. The idea of adaptation is used to link together a number of diverse conceptualizations of stress. A synthesis of existing theories and perspectives, including control theory, action theory, and the idea of chaotic systems, forms the foundation for the development of a Theoretical Framework of Adaptive Action Control. Some of the methodologies which can be derived from this theory are outlined, and the meaning and measurement of variables within this framework is then discussed.

The purpose of the theoretical framework developed and presented here is not merely to support, or act as an introduction to, the three empirical studies presented in Part Two of this thesis. Rather, this part of the thesis is a contribution to theory development in its own right, in a research area which suffers from a deficiency of theory.

CHAPTER TWO

THE VARIABLES IN STRESS RESEARCH

2.0 Introduction

This chapter moves away from a general critique of the relationship between theory, methodology, and empirical practice in stress research and considers variables typically measured in stress research. Rather than presenting and summarising findings in the manner of a literature review, there are a number of reasons why it is more useful here to present a different type of review and analysis: An analysis which is less concerned with with specific findings, than making a distinction between variables and the models and theoretical frameworks which attempt to explain relationships between such variables. (While these are of course implied by the variables used in stress research, explicit discussion of these theories will take place in Chapter Three.)

The need to present details of key findings in a literature review can obscure attempts to critically appraise theory; it becomes difficult to see the wood (theory) for the trees (specific findings). Second, while there is broad agreement on the classes of variables involved in stress research, there is less agreement over theory: The distinction therefore between variables and theoretical models already exists in this area. Third, in order to understand complex phenomena, it is often clearer if the components or parts of the phenomena are specified before examining how these components interact. In this chapter then, a description and discussion of variables will take place.

2.1 The variables in stress research

As is apparent from the brief outline of the history of the stress concept described in the previous chapter, stress is a very broad concept. Lazarus (1966) has described stress as more of a rubric, or general heading for an area of research rather a concept. Under this broad heading a very large number of variables have been measured and used to explore various aspects of stress. In describing the variables in stress research the intention is not to provide an exhaustive list, but to concentrate on variables which meet one or both of two criteria. The first criterion is that the variable is used in the empirical research in this thesis. The second, that the variable is important in the development of the theories and models which will be discussed in the next chapter. The description of variables will take place on a number of levels to include the historical background, the conceptual and methodological development, and the current status of the variable in stress research.

The increasing association between the concept of stress and the concept of health means that in order to understand why particular variables are measured, a description of a model of health (and disease) is required. Indeed the notion of stress as a factor in health has come to be the dominant notion of stress. Put simply, an informal model of health assumes that characteristics of the environment and the individual combine to produce individual health and disease. This is not a theoretical model of stress, but a general framework in which contemporary views of medicine fall. For example, in describing the causes of specific diseases, the idea of 'risk factors' usually includes both environmental and individual characteristics. Stress is itself often included as one of these risk factors.

It is within this framework that the variables in stress research will be discussed. A distinction will be made between environmental variables and individual variables. Distinctions between the individual and the environment can be theoretically problematic (e.g. Bandura, 1978). However, variables in stress research have been measured on these levels and so the distinction is useful in this context.

2.2 Variables located in the environment

To state that a variable is located in the environment suggests, perhaps in a tautological way, that it is not is an individual characteristic. The interdependence and mutually defining nature of the categories of environment and individual can (as indicated above) cause theoretical problems. In addition, such distinctions can lead to methodological and empirical difficulties, not least of which is the problem of objectivity. Variables which measure environmental characteristics are typically rated by the target individual (Frese & Zapf, 1988), thus it is unclear in what sense these variables are measuring a characteristic of the environment.

Despite such problems, the notion that certain characteristics of the environment can affect health is a very powerful one. It is particularly powerful where such environments, as life situations or life events like bereavement or job loss, are extreme. It is this category of environmental variable which will be discussed first.

2.2.1 Stressful life events (life stress)

The concept of life stress and its measurement as an independent environmental variable are central to nearly all research into stress. This variable has therefore been particularly influential in the development of models of stress and the selection of variables for inclusion in research. The historical background to the study of life events shows that the early work of Cannon (1929) and later Selye (1956) laid the foundations for the simple idea that environmental changes can lead to changes in health (see Chapter One).

However, it was Meyer (1951) who first made a systematic attempt to demonstrate a link between environmental events and health (Dohrenwend and Dohrenwend, 1974a; Thoits, 1983). Meyer (1951) encouraged doctors to use a life chart (containing information about life events and changes) as an aid to the diagnosis of patients' illnesses.

Following Meyer's work, research into the relationship between life events and illness fell into three categories: The first examined the psychological effects of particular life events; the second investigated the effects of multiple events on the physical and psychological health of general community samples; and the third attempted to discover the number and type of events which preceded the hospitalization of psychiatric patients (Thoits, 1983). Only the second type of research will be discussed here, as it is mainly in this area that the development of life events measures took place.

One of the first, and certainly the most influential piece of research to establish life events as a variable in stress research was published by Holmes and Rahe in 1967. Their measure, called the Social Readjustment Rating Scale (SRRS), contained a list of 43 life events and a corresponding weighted score (based on the amount of adjustment each event was judged to require). Following publication of this measure attempts were made by Holmes and his colleagues (e.g. Holmes & Masuda, 1974; Rahe, 1974) to relate scores on this measure to subsequent reports of illness. In general, correlations of approximately .3 were observed between these measures. Although these correlations could be viewed in some ways as unpromising, life events research expanded at a remarkable rate over the 1970s and early 1980s perhaps, as will be discussed later, because of the desire to demonstrate that a relationship must exist. Holmes (1979) estimated that since its publication, over 1,000 articles had been published on the SRRS alone. Along with this large number of articles, a number of books devoted entirely to life events research were published (e.g. Barrett et al, 1979; Dohrenwend & Dohrenwend, 1974b, 1981; Gunderson & Rahe, 1974).

From the early 1970s, the methodological development of life events measures was soon to predominate life events research. As Kasl (1983) has noted, this trend is illustrated by a comparison of the contents of two of the major books on life events published seven years apart (Dohrenwend & Dohrenwend, 1974b, 1981). The earlier volume paid little attention to methodological issues, while the second is "overwhelmingly methodological" (Kasl, 1983, p. 79). The main reason for this attention to methodological issues was the low, but consistent correlation between measures of life events and measures of health. Given the severe nature of most events included on inventories, and the desire to demonstrate a link between life events and illness, a correlation of .3 was unsatisfactory. As Thoits (1983) expressed it, "the weak explanatory power of events is an embarrassment" (p. 42).

A number of specific methodological issues have been addressed (e.g. Mechanic, 1974; Rabkin & Struening, 1976). These have included the question of how life events can be weighted to accurately represent the 'stressfulness' of each event (e.g. Fontana et al, 1979; Horowitz et al, 1979; Redfield & Stone, 1979), and whether it is the amount of change per se or the relative desirability of life events which determines health outcomes (Brown, 1974; Muller et al, 1977; Ross & Mirowsky, 1979). However, methodological refinements in the measurement of life events and health seem to do little to increase this explanatory power (e.g. Kessler et al, 1985).

In the last five years, the initial enthusiasm for life events research has waned. This has occurred for two closely connected reasons. The first related to the status or meaning of life events as stressors, and the second, theoretically connected reason is connected with the methodological development of measures of less severe, chronic daily events and daily hassles. Each of these reasons will be discussed in turn.

A dissatisfaction and disenchantment with the status of life events as stressors has been apparent for some time (Monroe, 1982; Perkins, 1982), although it is only fairly recently that researchers have suggested abandoning traditional life events research altogether (Sandler & Guenther, 1985; Thoits, 1983). Even if methodological improvements in life events measures produced stronger correlations between these measures and measures of illness, it is unlikely that such a finding would contribute much to our understanding of the relationship between stress and illness. This and other conceptual and interpretive difficulties have almost certainly forced the view that life events are simply "methodological expedients" (Kessler et al, 1985, p. 539), rather than theoretically powerful constructs. These conceptual problems can be seen to arise from the question of what 'life stress' actually is, and the question of whether it is possible or desirable to define and measure it as an independent variable when many life events do not simply 'happen' to people. Life events such as divorce or changing jobs could equally be a consequence or a cause of illness. If stress (in terms of life events) cannot be measured independently of outcome variables, particularly psychological symptoms, how can the relationship between stress and health be adequately demonstrated?

This debate has been most apparent in the response by the Dohrenwends and others (e.g. Dohrenwend & Shrout, 1985; Dohrenwend et al, 1984) to the development of measures of daily hassles by Lazarus and his colleagues (e.g. Kanner et al, 1981; Lazarus, 1984). The Dohrenwends argued that such measures were contaminated by dependent variables, in particular psychological health. The defence of these methodologies was both theoretical and methodological. Lazarus et al (1985) in their reply to these criticisms stated that:

> some of the confounding...reflects the fusion of variables in nature rather than being merely the measurement errors of researchers. If we try to delete the overlap in variables of genuine importance, we will be distorting nature to fit a simpler metatheory of separable antecedent and consequent variables. We urge researchers to be very wary of throwing out the baby with the bathwater in their efforts to objectify stress as an event in the environment. (p. 778)

As is clear from the history of the stress concept discussed earlier in this thesis, this debate has a good vintage. Is stress a stimulus, or a response, or both? The approach taken by the Dohrenwends can be described as medical or epidemiological (one of the four areas of historical background discussed in Chapter One) in that they view stress as a cause of disease, and as a phenomenon which should therefore be measured as objectively as possible. Lazarus et al, on the other hand, can be identified with a different view, in which stress is partly viewed as a possible cause of illness, but more importantly it is an antecedent of psychological adaptation. These adaptive processes are complex, and cannot be easily separated from their antecedents, either theoretically or methodologically. The adaptive processes which may be set in motion by the occurrence of a life event may result in the occurrence of other life events. "What is a consequence at Time 1 can become an antecedent at Time 2; and the cause can either be in the person or the environment" (Lazarus & Folkman, 1984, p. 293). In the same way, as stated above, illness may be a cause, as well as a consequence of life events.

Lazarus and his colleagues were not the only researchers to attempt to measure chronic stress and minor events (e.g. Eckenrode, 1984; Monroe, 1983; Stone, 1981; Stone & Neale, 1984; Stone & Neale, 1984; Neale et al, 1987). While life events research has decreased, research using measures of hassles of chronic stress have become more popular. Interest in measuring general life stress as a variable has also decreased considerably as researchers have become more aware of the numerous other variables (discussed below) involved in the production of individual health. There has been a great deal of criticism of research which adopts simple cause-effect models of stress and health. Several researchers have encouraged a move towards more process-oriented research (e.g. Kasl, 1983; Thoits, 1983).

2.2.2 Environmental characteristics

The recognition that the stimulus-response relationship between events in the environment and health implied by life events research is over-simplified leads to a consideration of other aspects of the environment that may be associated with health. The effect of a divorce, for example, depends on the environmental context in which the event occurs (as well as the individual context). In addition, negative (and positive) environmental influences on health cannot all be conceptualised as stimuli such as life events. The environment can also be considered to consist of situations, or to possess particular characteristics which are not easily reducible to discrete stimuli. In this section, three variables which tap environmental characteristics will be discussed; social support, extrinsic job characteristics, and home/family demands.

Social support

Social support (as the term itself suggests) may play a positive role in the production of health, although this role is by no means clearly established (e.g. Pearlin & Schooler, 1978; Thoits, 1982; Turner, 1983). The relationship between social relationships and health has, like the relationship between emotion and health, been recognised as significant for a very long time. Also, like the relationship between emotion and health, it is only in fairly recent times that this relationship has been studied in a systematic way. Although the negative aspects of early social relationships have played an important role in the clinical literature for some time, the possible beneficial aspects of informal adult social relationships have only received detailed study during the last twenty years or so (Suls, 1982).

The literature on social support is extensive (e.g. Caplan, 1974; Gottlieb, 1981; House, 1981; Sarason & Sarason, 1985). According to Wilcox and Vernberg (1985) more attention has been paid to this variable than all other stress-related variables put together. Many comprehensive reviews of social support already exist (e.g. Cohen & Wills, 1985; Henderson, 1984; Kaplan et al, 1977; Sarason et al, 1985a), and it is not the intention here to repeat these overviews. Instead, as with all variables discussed in this chapter, the aim is to identify issues concerning its conceptualization and measurement as a component in the hypothesized relationship between stress and illness.

As stated above, the idea that social relationships can influence health is a very old one. Given this fact the question arises of why it has only recently begun to be studied as a variable in stress research. One reason can be found in the low correlations between measures of life stress and measures of health, and the need to find ways of including other variables which could account for such correlations (Wilcox & Vernberg, 1985). The earliest measures of social support were often crude and relied on rather superficial conceptualizations of social support (e.g. Vaux, 1982). As with measures of life stress, measures of social support have become increasingly sophisticated, while at the same time the conceptualization of social support as a relatively pure independent variable has proved to be problematic. Several authors have pointed out the possible confounding of social support measures with other variables such as personality and life events (e.g. Henderson, 1984; Thoits, 1982; Turner, 1983).

A further problem in interpreting the effects of social support can be seen in the relationship between social support and health. Does social support have a beneficial effect on health in itself (main effects), or does it only operate to protect the individual when levels of stress are relatively high (buffering effects)? This issue has generated considerable theoretical, methodological and empirical work (e.g. Aneshensel & Stone, 1982; Turner, 1981). However, this debate has thus far been inconclusive, and also perhaps too simplistic. The effects of social support on health depend on a great many other factors, and it is quite possible or even likely that both main and buffering effects could be operating at the same time (Brown & Andrews, 1986; Cohen & Wills, 1985; Frese & Zapf, 1988).

The determined methodological and theoretical efforts to improve our understanding of the role of social support demonstrate the continuing importance of this variable in stress research. Indeed many researchers consider this variable to be the most critical in determining health outcomes, despite the fact that clear evidence for the extent and nature of its role remains elusive. The term social support, in a similar way to the term stress, implies a causal relationship taken from a physical or engineering analogy of stress (see Chapter One). The term social support also belies the complexity of the relationships between social support and health, and social support and individual variables such as coping. It is likely that further attempts to measure social support will have to be based on a broader conceptualization of what social support is, and how it may operate.

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Extrinsic job characteristics/contexts

Environmental variables which are intrinsic characteristics of jobs are discussed below in section 2.2.3. Here, those characteristics of the work environment which are not a direct consequence of work design or work tasks, but reflect the context of work activities are discussed. Warr (1987) identifies four extrinsic job characteristics: availability of money; physical security; interpersonal contact; social position. Two of these characteristics, availability of money and social position, are currently of relatively little theoretical or methodological importance as variables in stress research. In addition, little evidence is available on the effects of these variables on health (Warr, 1987). As interpersonal contact, in terms of social support, was discussed in the previous section, only physical security will be discussed here. This variable is both theoretically important and highly relevant to stress in computer-supported work.

A lack of physical security or physical discomfort, in any environment, is likely to have effects on health. Some of these effects will be quite direct, for example, physical injury or other physical damage. More relevant to the study of the relationship between stress and health is either where work is made more difficult, or where discomfort (rather than direct injury) is caused by characteristics of the physical working environment. Preventing physical injury and ensuring efficient performance (as defined by productivity) at work have always been important, but there has been little examination of physical security or comfort as a variable in stress research, or as a job characteristic. However, ergonomics and human factors research has broadened considerably in the last few decades to include psychological and affective responses to the interaction with the physical environment, machinery, and equipment. This trend is evident from handbooks of human factors (for example see Salvendy, 1987).

The measurement of aspects of the physical environment has presented relatively few conceptual or methodological problems. Compared to other environmental variables these are clearly both external and objectively quantifiable. For example, the measurement of noise, posture, temperature, lighting conditions, or the response time of a computer system offer a methodological clarity and certainty quite absent from the other environmental variables discussed so far. The central conceptual difficulties do not involve measurement, but the interpretation of the effects of these variables on health. A major problem is separating the influence of an extrinsic job characteristic (e.g. slow computer response time) from an intrinsic job characteristic (e.g. control or posture). Rather than discuss these issues generally, research into the relationship between the physical characteristics of computer systems and their effects on health will be reviewed, an example relevant to the topic of stress and computer-supported work.

Early interest in stress and computer-supported work focussed almost entirely on the effects of aspects of the physical environment, usually Visual Display Units (VDUs) on the health of operators. It was found that intensive work with VDUs may produce high levels of general symptom reports and reports of eye-strain (e.g. Thomas, 1984). There were a number of problems with this approach, however. First, intensive work with VDUs often involves intrinsic job characteristics which are also thought to influence health (Howarth & Istance, 1985; Sauter et al, 1981; Smith et al, 1983; Eason, 1984). Second, when more 'objective' measures of eye-strain were used they were not associated with the subjective measures typically used in this research (Dainoff, 1982; Dainoff et al, 1981). Third, the obtained increases in reports of general symptoms are difficult to interpret. In this research they were considered to be the consequence of the physical environment (e.g. posture, VDUs), while in psychological stress research general symptoms were measured in order to examine the supposed effects of the psychological environment. In many of these studies the physical environment per se was not measured, but group comparisons between VDU users and non-VDU users (often inadequate as control groups) were made (Laubli & Grandjean, 1984). However, some studies made more direct measurement of the physical properties of the VDU (Cakir et al, 1980).

In some ways, this point is similar to one made by Mason (1971) concerning the nature of the primary mediator in stress responses. For Selye (e.g. 1956) this primary mediator could be a 'pure' physical stimulus, such as starvation. Mason argues both theoretically and with some empirical evidence (Mason, 1971, 1975; Mason et al, 1976) that all physical stimuli have a strong psychological component, and it is this component (perhaps threat or the absence of threat) which is the primary mediator of the stress response.

Recent reviews of the evidence on the effects of VDUs on health suggest that physical properties of VDUs may have some physical effects on operators, and it is certainly advisable to take precautions and follow ergonomic guidelines (e.g. Mackay, 1980; Stellman & Henifin, 1983). However, the reasons for increased symptom complaints among those who work intensively with VDUs are also likely to reflect intrinsic job characteristics, such as workload and pacing.

The current status of the physical environment as a variable in stress research is unclear. As much of the research using this variable is epidemiological, comparing groups or occupations, it is difficult to observe its possible effects independently of occupation or job characteristics. There has been a tendency to ignore this variable (Taber et al, 1985) though it may play quite an important role in health outcomes, particularly where the physical environment is physically and psychologically threatening, or where it is difficult to control. An example of the latter case is Sick Building Syndrome where a higher incidence of certain symptoms is found in those who work in modern office environments (e.g. Hedge, 1984). Some researchers have argued that this is due as much to the uncontrollability of heating, ventilation and lighting, as it is to the physical conditions in themselves (Wilson & Hedge, 1987).

The central difficulty then with using aspects of the physical environment as a variable in stress research is causal interpretation rather than measurement.

Nonwork demands and characteristics

Another important environmental variable relates to the demands and characteristics of the nonwork environment, home and family life. One of the words used in the title of this section, 'nonwork', reveals a common bias among researchers who may view work as the predominant area of life in which demands occur, despite the fact that for many people who work, particularly women, home life may be equally as demanding as work. Apart from clinical studies of family life (e.g. Laing & Esterson, 1964; Vetere et al, 1987) or studies of particular family/home circumstances, such as separation or divorce (e.g. Brehm, 1987) this variable has not been systematically studied. As such it has little historical background as a variable in stress research.

The absence of general measures of this variable is surprising, particularly given the growth in the study of occupational stress. The work environment is not the only influence on health outcomes. A thorough examination therefore of the influence of work related variables on health requires that the environment outside work is also assessed, so that its effects can be controlled, or at least taken into account (Gutek et al, 1988). Interestingly, most measures of characteristics outside work are used as a dependent measure to assess the 'spillover' effects from stress at work to home, rather than as an independent variable affecting health. On the other hand, characteristics outside work can also be considered to compensate for the characteristics of work (e.g. see Kabanoff, 1980). One exception to this lack of measures, although not explicitly assessing characteristics outside work, is the measurement of role conflict between work and life outside work which attempts to evaluate the degree to which the role demands in each area interfere with or disrupt one another (e.g. Kopelman et al, 1983).

Neglect of nonwork variables in stress research may partly be due to the complexity of nonwork environments. For example we can include role, demand, family, attitudinal and leisure variables as part of the nonwork environment (Gutek at al, 1988). However, it may be unnecessary to obtain such detailed information about the nonwork environment in stress research. As suggested by Warr (1987) in his vitamin model of the environment and mental health, the psychological characteristics of any environment may be assessed in a similar way. For example, some of the job characteristics discussed below, such as workload or control, are equally applicable to nonwork environments.

The measurement of nonwork characteristics as a variable in stress research is important. The independent effects of such a variable on health may be positive, negative or neutral, further complicated by the reciprocity between work and nonwork environments. Both compensatory and spillover processes may operate, while at the same time the characteristics of nonwork environments may in part be formed by the characteristics of work environments and vice versa. Occupational stress research has encouraged the definition of this variable (if it can be thought of as a single variable at all), as a catch-all 'other' category to measure all environmental characteristics outside work. The reluctance to become more involved with the measurement of this variable, apart from the kind of bias discussed in the introduction to this section, is that it opens up a new area of complexity and difficulty. In most stress research, the number and complexity of variables is kept almost to a minimum. To acknowledge this broad class of influences on health, and consider measurement of variables in it more seriously, is beyond the scope of most current practices in stress research.

2.2.3 Intrinsic job characteristics

Since mechanization and mass production, intrinsic job characteristics have been measured for several different reasons. Only more recently have these reasons come to be associated with the use of job characteristics as a variable in stress research. However, it is worth noting here at least some of the historical background to these variables. The requirement to accurately measure the characteristics and activities in jobs arose partly from the tradition of 'scientific management' espoused by Taylor (1911). One of its main principles involved the breaking down of complex jobs into simpler tasks in order to increase the efficiency of the worker and hence productivity. This led to 'time and motion' studies of work which included careful observation and measurement. Around the same time a number of other concepts from industrial, applied and biological psychology (such as fatigue and monotony) also required the measurement of task and job characteristics (e.g. Rose, 1978).

The perception of jobs as simply a series of (measurable) tasks, and the application (and sometimes misapplication) of Taylor's principles in industry gave rise to a number of problems, including high labour turnover and dissatisfaction (e.g. Algera, 1984). This led to a change in the aims of job measurement from increasing efficiency to increasing worker satisfaction by job enlargement and enrichment (Rose, 1978). The more objective characteristics of jobs measured in time and motion studies came to be seen as less important determinants of satisfaction than the subjective perceptions of jobs. However, the task of changing jobs to improve satisfaction and increase motivation was hampered by a limited "capability to measure (and thereby understand) what happens when jobs are changed" (Hackman and Oldham, 1975, p. 159).

The Job Diagnostic Survey developed by Hackman and Oldham (1975) was designed to measure a number of job characteristics including skill variety, task identity, task significance, and feedback. These measures reflect perceptions of the job, rather than its objective characteristics. The theoretical framework in which these measures were used, the Job Characteristics Model, used motivation, satisfaction and work performance as dependent variables (e.g. Hackman & Oldham, 1976), and was therefore not a model which in any way attempted to explain the relationship between job characteristics and health. The measurement of job characteristics as a research tradition was initially quite separate from stress research (Karasek, 1979). However, this changed with the inclusion of dependent health variables (Wall et al, 1978), and perhaps more importantly the inclusion of a previously unmeasured job characteristic, environmental demands or 'stressors' (e.g. Caplan et al, 1975; Karasek, 1979).

As in the case of nonwork characteristics described above, the number of variables which can be measured in the work environment is almost unlimited. In this section the measurement of two job characteristics of great theoretical importance, workload and control, will be discussed.

Workload

As mentioned above, the measurement of variables in the work environment is relatively new to stress research. The measurement of workload is no exception. Although early work by Taylorists and industrial psychologists did include measures of workload, these were in studies of fatigue and performance rather than stress per se (Meijman & O'Hanlon, 1984). The tradition of workload measurement in industrial and more specifically engineering psychology has continued to expand, generating a great many conceptual and methodological developments. However, reviews of the conceptual literature (e.g. Gopher & Donchin, 1986), and methodological techniques (e.g. O'Donnell and Eggemeier, 1986) reveal two distinctive trends.

First, the measurement of workload in these areas is quite separate from and unrelated to the measurement of workload as a job characteristic. For example, both the reviews mentioned above make no reference to workload as a job characteristic. Nor is there any reference to researchers who measure workload as a characteristics of jobs such as Karasek (e.g. 1979). This should not necessarily be viewed as a weakness in this type of research. The aims of measuring workload within this tradition are rather different from those in other research traditions such as occupational stress. A definition from Gopher and Donchin (1986) helps to clarify these differences: "...mental workload may be viewed as the difference between the capacities of the information processing system that are required for task performance to satisfy performance expectations and the capacity available at any given time" (p. 41-3). The key features which distinguish this approach from, say the occupational stress and job characteristics approach, are the emphases placed on cognition and tasks. This level of analysis is too detailed to be operationalised in most work settings, but extremely useful for human factors and experimental work, where the user-machine system and the task can be more fully controlled, defined and measured. Also, as human factors research and engineering psychology are partly concerned with the development and design of machinery, investigations which use measures of workload are often used "to assess the machine, not the human" (Moray, 1982, 37).

A second trend which emerges from this literature is the focus on the relationship between workload and performance, to the exclusion of the relationship between workload and variables which may affect health (e.g. Meijman & O'Hanlon, 1984). Connected with this is a striking lack of research into those factors which contribute to subjective feelings of load (Moray, 1982). The emphasis on the performance of the user-machine system seems to preclude any serious consideration of these other factors. Here again, this is not necessarily a shortcoming of this type of research, as the aims of the research must be taken into account, before any judgement is made.

The measurement of workload in user-machine systems in terms of overall performance can in some ways be compared to the measurement of job characteristics in the Taylorist tradition. An important mutual aim in measuring these variables is to increase performance or the efficiency of work systems. Indeed the term "Cognitive Taylorism" has been used to describe much of the human factors research into human-computer interaction (Frese et al, 1987, p. v). The measurement of workload within this tradition has little direct relevance to the measurement of workload as a job characteristic, or as a variable in stress research. This is not to suggest that important links do not exist, rather that these links have not as yet been explicitly made, though this limitation has noted by several commentators (e.g. Meijman & O'Hanlon, 1984; Moray, 1982).

The measurement of workload, explicitly as a variable in stress research is very recent indeed. The notion that high workload can have an influence on health can of course be viewed as 'common sense', and, as Warr (1987) points out, asking if someone has 'too much' to do within a certain time period almost makes the relationship between high workload and health tautological.

Some of the earliest studies which used measures of workload in relation to health asked explicitly about 'overload' rather than some other assessment of workload (e.g. Kahn et al, 1964). In addition many of these measures of subjective overload were short and assessed relatively few dimensions. Some measured only the single dimension of subjective quantitative overload. The focus on this dimension of workload measurement in occupational stress research has continued for some time (e.g. Caplan et al, 1975; Karasek, 1979; Israel et al, 1989).

In contrast to the efforts made within the human factors/engineering psychology tradition (discussed above) to clarify the concept and measurement of workload, occupational stress researchers have done little. Unlike other variables in stress research, workload has not received close conceptual and methodological scrutiny. The reasons for this are unclear, but the following factors may have played some role. First, it may be that workload, as a variable, became absorbed into the general pool of job characteristics, and so little attention was paid to it as an individual variable. Second, the 'common sense' status of the observation that having too much to do can be detrimental to health undermined a thorough consideration of the potential complexity of workload. Third, the idea that both overload and underload can have negative effects on health (Frankenhaeuser & Gardell, 1976) may have confused the causal status of workload as a variable in stress research. Fourth, the general acceptance that workload is an intervening variable (e.g. Gopher & Donchin, 1986) between the person (or operator) and the task (and also sometimes machine) means that it is not, in terms of stress research, a purely independent variable. This latter point, of course, applies equally to many of the other variables already discussed.

A fifth reason involves the association between the next job characteristic to be discussed, control, and workload. The important and highly influential finding by Karasek (1979) that high workload seems to have negative effects on health only when the level of control over work is low further complicates the causal status of workload.

A number of theoretical and methodological issues do exist, though these are not widely debated. One concerns the limits of workload as a concept. Role ambiguity, role overload, physical workload and the pacing, scheduling, predictability and complexity of work would all seem to be quite closely related to a general notion of workload, although the measures are generally confined to perceptions of quantitative workload. Another issue involves the specificity in measures of workload. Many work environments involve different categories of workload depending on specific demands. For example, a particular job may involve working with people, using tools, and administrative work. General measures of workload do not make these distinctions, so their diagnosticity in relation to health outcomes is reduced. A third problem, common to the measurement of many variables in stress research, is the issue of subjective and objective measurement. Clearly subjective measurement on its own has a number of uses, but without some attempt to also use objective measures, workload as a variable in stress research is both conceptually and methodologically limited.

Despite differing levels of analysis and aims, at least some of the theoretical and methodological advances made in workload assessment in human factors research could be applied to workload assessment as a job characteristic in stress research.

Control

The finding by Karasek (1979), that control (described by Karasek as job decision latitude) is critical in determining the impact of workload on health, has given control (as an environmental variable) an extremely important role as a job characteristic in stress research (e.g. see Sauter et al, 1989). Here though, only those studies which have examined the direct effects of control on health will be examined. The theoretical status of control as a moderator or mediator will be discussed in the next chapter on the theoretical relationships between variables in stress research.

Control has been measured as a job characteristic since the rise of the job redesign or job enrichment movement, and the development of the Job Characteristics Model (Hackman & Oldham, 1975). In this model the term autonomy, rather than control, is used to indicate control over aspects of the job such as the procedures adopted for completing tasks, and the pacing and scheduling of tasks. As discussed earlier, dependent variables such as satisfaction, motivation, and work performance rather than health have been used, and only a few studies have examined the direct effects of control, or autonomy on health (Jackson, 1989; Spector, 1986). While control does have direct effects on health, the work of Karasek (1979) has been so influential that control is often only considered in conjunction with workload or job demands.

The measurement of control has developed very little since the measure of job decision latitude by Karasek (1979). Karasek defined job decision latitude as "the working individual's potential control over his tasks and his conduct during the working day" (p. 289-290). Despite this quite broad definition, his measure contained only two factors, skill discretion and decision authority, with four items in each factor. In general, measures of control as a job characteristic are lacking both methodologically and theoretically. For example, they do not consider the very different domains in which control can operate such as tasks, scheduling, and the physical environment (Ganster, 1988).

The operationalisation of control as a job characteristic presents a number of difficulties. Most central is the distinction between control measured as a perception or belief, and control when it is defined externally and more objectively by the task characteristics of the particular work environment, for example in paced versus non-paced work. There seems to be evidence that both objective control and subjective control are important for health outcomes, but there is rarely any comparison of these two types of control, or of the possible relationship between them (e.g. Folkman, 1984).

The importance of control as a job characteristic is assured by the continuing popularity of the interactive model of the relationship between control, workload and health proposed by Karasek (1979). Recent studies however have not fully supported this pattern of relationships between variables suggested by Karasek's model (e.g. Landsbergis, 1988; Perrewe & Ganster, 1989), though the measures of control used in all these studies are inadequate given the methodological and theoretical issues discussed above. But the importance of control will only be more fully realised when a number of issues are addressed. First, the relationship and potential confounding between measures of control as an environmental variable and as a individual characteristic must be examined. Second, the measurement of control as a job characteristic requires that different domains are assessed for their controllability, and, more importantly, that there are stronger and clearer theoretical views about what such measures actually tap. The findings from other areas where the relationship between control and stress is studied, suggest complex and contradictory findings for the role of control (e.g. Frese, 1989; Thompson, 1981). Unless methodology in the measurement of control as a job characteristic is developed, the dominance of the relatively simple model proposed by Karasek (1979) will continue.

2.3 Variables located in the individual

Clearly, many of the same problems in defining an environmental variable exist when attempting to define an individual variable. It is apparent that most of the environmental variables discussed above are also individual variables inasmuch as they are measured on an individual basis, and refer to perceptions of environments. The distinction here (again based on mutual definition) is that individuals are asked for perceptions not of the environment, but of aspects of their own behaviour, thoughts, feelings, attitudes and so on. A very large number of variables which can be located in the individual, or thought of as individual characteristics, have been used in stress research. In this section, on the basis of their methodological and theoretical importance, three categories of such variables will be considered: Individual coping, personality and attitudes, and well-being.

2.3.1 Individual coping

Here those variables which attempt to measure individual coping will be discussed. Before this however, it is necessary to discuss in some detail the concept of coping. Perhaps more than any other variable discussed in this section, the construction of measurement techniques for coping has been severely constrained by inadequate conceptualization, though as will be demonstrated, this is largely the consequence of the complexity and range of behaviours which fall under the general heading. The observation that health may be affected by the way in which people respond to or interact with their environment, particularly when that environment is considered to be stressful, appears to be so obvious that it hardly needs to be stated. It is perhaps a result of this obviousness that only very recently have efforts been directed towards the measurement of coping as a variable in stress research. The above observation is a description of such a general process that attempts to measure or assess it are likely to be extremely limited. Also, while most of the other variables in stress research discussed thus far contain implicit models (albeit simple ones) of their operation, the concept of coping is so broad that implicit theoretical models which could guide its measurement are unclear.

Although measures of coping are a fairly recent development, the concept of coping is not. Coping has its origins in two different research traditions, animal experimentation and psychoanalytic ego psychology (Lazarus & Folkman, 1984). Each of these traditions will be discussed in turn.

In animal experimentation, coping is considered to be a biological/physiological phenomenon, closely related to the concept of adaptation (e.g Hamburg et al, 1974). In general, the function of coping is associated with the reduction of physiological arousal produced by threatening or novel situations (e.g. Ursin et al, 1978). Earlier research by Cannon (e.g. 1939) and Selye (e.g. 1956) had already demonstrated the association between threat and physiological responses. The concept of coping within this research tradition has been applied to human as well as animal subjects. Using a variety of techniques, physiological measures are taken and related to relatively objective characteristics of the environment in laboratory and field settings. Coping, as a response, is often inferred from the particular patterning of physiological and hormonal changes associated with environmental characteristics, such as controllability (e.g. Frankenhaeuser, 1980).

This conceptualization of coping, as a reduction of physiologial activation or arousal, is based more on a description of the effect of a coping response than a description of coping itself (e.g. Miller, 1980). While knowledge of the physiological bases of responses to threat is crucial to the analysis of the relationship between coping and health, the contribution of this research tradition to the measurement of coping as a variable in stress research is quite small (e.g. Lazarus & Folkman, 1984). This is partly due to the physiological nature of the concept of coping within this tradition, and also that much of the research conducted in this tradition infers coping indirectly from physiological measures.

An important contribution has been made by researchers in this tradition by the findings which relate to the psychological and physiological correlates of active and passive coping (Frankenhaeuser, 1980, 1986; Ursin et al, 1978). Like other research in this area however, its generalisability must be questioned. While the distinction between active and passive coping may be theoretically important, the use of experimental conditions to manipulate controllability limits the range of subjects' coping responses, and perhaps its applicability to other situations outside the laboratory.

The second research tradition, psychoanalytic ego psychology has shown a more direct approach to the definition, conceptualization, and measurement of coping. The major differences between these two traditions are that cognitions thoughts and feelings, while largely ignored in the former tradition, play a central role in ego psychology. One of the functions of anxiety described by Freud (e.g. 1946) was to act as a physiological signal to alert the individual to potential or actual threats so that some kind of adaptive response could be made. The tradition of animal experimentation in coping research described above, while starting at a similar point, tends to remain at the physiological level.

As discussed in section 2.1.1., the focus for ego psychologists such as Haan (1977), Vaillant (1977) and Menninger (1954a, 1952b) was not (as it was for Freud) anxiety produced by unconscious and potentially pathological mental conflicts. Rather, ego psychologists were concerned with what they described as the conflict-free ego sphere and the processing of potentially threatening information about environmental events or characteristics. These researchers viewed coping in a variety of ways. Underlying this variety was a common idea of coping as a behavioural or psychological response to threat, conflict or anxiety. The development of classifications of ego processes (Haan, 1977), and regulatory devices (Menninger, 1954a, 1954b) introduced the idea that a particular coping response was part of a much larger repertoire of coping behaviours.

This work was to have a large influence on later concepts and measurements of coping (e.g. Lazarus & Folkman, 1984). The research conducted by these ego psychologists was often based on individual case studies. While health was considered to be an important dependent variable, the measurement of coping as a variable to predict health outcomes was seen as less important than attempting to understand the processes and dynamic aspects of coping.

Based partly on this work, one of the first attempts to classify coping as a variable in relation to health variables was made by Lazarus, and described most fully in the highly influential book *Psychological Stress and the Coping Process* published in 1966. Three key differences exist between this concept of coping and those put forward by ego psychologists. First, ego psychologists tended to emphasise the role of the person, or the personality in coping responses. In contrast, Lazarus suggests that both the person and the environment are important determinants of coping responses (e.g. Lazarus et al, 1974). Second, the coping responses of active problem-solving was omitted from the psychoanalytically oriented classifications of ego psychologists, while it is central in Lazarus's classification of coping responses. The third difference is Lazarus's introduction of cognitive appraisal as part the coping process. The inclusion of appraisal emphasises coping as a response to the perception of threat, rather than primarily a response designed to reduce emotional arousal.

Early research using this conceptualization of coping was mainly experimental (e.g. Lazarus et al, 1962; Lazarus & Alfert, 1964), and either used manipulations to restrict the type of coping response the subject could make, or assessed coping through interviews in order to make inferences about appraisal. Up to the late seventies, coping was mainly measured indirectly, or via related concepts such as cognitive style, ego development, and sense of mastery (e.g. Moos & Billings, 1982). Around the late seventies and early eighties, however, a small boom occurred in the number of coping measures developed (e.g. Billings & Moos, 1981; Folkman & Lazarus, 1980; Pearlin & Schooler, 1978; Stone & Neale, 1984). These measures fit more clearly into the stress and coping paradigm, and have been used in studies of well being. Both the direct effects of coping on health outcomes (e.g. Billings & Moos, 1981; Folkman & Lazarus, 1985), and indirect or buffering effects have been examined (e.g. Pearlin et al, 1981). This distinction is the same as those discussed above between the main and buffering effects of social support, and the direct effects of control on health, and the interactive effects proposed by Karasek (1979).

The theoretical and methodological development of these and new measures of coping has been hampered by a number of difficulties. Here, those difficulties which are most relevant to the development of measures of coping as a variable in stress research will be discussed. One of the most general difficulties arises from any attempt to operationalize the simple description of coping given at the start of this section. While it may be accurate to say that the way in which a person responds to or interacts with a stressful environment will have implications for health, it is not at all clear which aspects of the individual's response or interaction should be assessed, nor how this assessment should be made. The range of behaviours, emotions, and cognitive processes which can be included in this category of responses to, or interactions with, the environment could encompass almost all human psychological phenomena. The question remains of which phenomena should be classified as coping and which should not.

This problem is compounded by the tendency for measures of coping to be derived empirically rather then theoretically, which makes theory difficult to test and develop (Carver et al, 1989). Although relatively sophisticated theoretical models of coping are available, it is often the case that these are not fully operationalized in the measures and designs used in studies. The "Ways Of Coping" measure, for example, developed by Folkman and Lazarus (1980, 1985) contains only descriptions of cognitive and behavioural efforts, which represent just one part of the full model of coping developed by Lazarus and colleagues (e.g. Lazarus, 1966; Lazarus & Folkman, 1984), which also includes primary and secondary cognitive appraisal, and reappraisal.

Another response to the problem of describing and assessing coping has been to use a circular definition of coping such that coping becomes any response to an appraisal of threat or stress. This is operationalized by asking people how they respond generally to stressful situations (e.g. Endler & Parker, 1990; Rhode et al, 1990), or more typically respondents are asked to report their responses to a particular situation or event (e.g. Folkman & Lazarus, 1980; Folkman et al, 1986; Holahan & Moos, 1987; Parkes, 1984; Stone & Neale, 1984; Wood et al, 1990). If respondents are describing responses to events or situations which were at least partially within their control, it could be argued that these measures assess coping responses after coping has in some way failed. If a coping response was effective, it is likely that the situation would be more easily forgotten, or less salient, than a situation where a coping response was ineffective.

A related issue is whether coping behaviours are consistent within individuals across situations. If so, then asking someone what they generally do, measures a trait or style. If however coping is not particularly consistent across situations, then asking someone what they did in a particular situation may be more useful. In this case it is difficult to see what such information about coping behaviour reveals, beyond the person's behaviour in that particular situation. However, even in those studies which do ask about reactions to a specific event, the resulting pattern of coping strategies is still taken as representative of general behaviour in stressful situations.

Lazarus & Folkman (1984) have argued that even if people do have preferred coping styles, it is more useful to study the process of coping by examining how strategies and behaviours change over a coping episode, rather than attempting to demonstrate that stability exists. However, it is difficult to incorporate a process model of coping in traditional cross-sectional stress research where the effects of environmental and individual variables on health outcomes are studied.

A further difficulty in developing measures of coping concerns the role of the environment in determining coping behaviours. While coping is a variable located in the individual, situational as well as individual factors play a central role in determining coping behaviours. In Lazarus's model of coping for example, primary appraisal establishes what, if anything, is at stake in a particular stressful encounter. Secondary appraisal evaluates what, if anything, can be done in that situation to minimize harm and maximize benefits. Following these appraisals, coping is then defined as the "the person's cognitive and behavioural efforts to manage (reduce, minimize, master or tolerate) the internal and external demands of the person-environment transaction that is appraised as taxing or exceeding the person's resources" (Folkman et al, 1986a, p. 572). According to this model, coping may be largely determined by secondary appraisal, which in turn may be determined by features of the situation, and of the individual. If coping is to be considered as a variable in stress research, then the most basic question which must be addressed is whether or not particular coping strategies do actually have an influence on health outcomes (e.g. Aldwin & Revenson, 1987; Kessler et al, 1985). Given the situational influence in the use of particular coping strategies the answer to this question is almost impossible to determine in many circumstances. For example, in situations where an evaluation of low environmental control is made (through the process of secondary appraisal), and few or no coping options are available, it would seem problematic given current approaches to the assessment of coping to determine whether a particular coping strategy would in this instance have implications for health outcomes.

The model and measure of coping proposed by Lazarus and his colleagues is intended to reflect the "richness and complexity that characterise actual appraisal and coping processes" (Folkman et al, 1986a, p. 578), and for this reason may not be a suitable basis for assessing coping as a variable in stress research. However, Folkman and Lazarus have suggested in this paper and elsewhere that one of the major challenges to stress and coping research is to develop measures of coping which can assess styles and preferred coping strategies, without sacrificing the richness and complexity of coping processes (e.g. Folkman & Lazarus, 1981, 1984, 1985).

Some recent attempts to develop general measures of coping (Carver et al, 1989) and measures of coping with work-related stress (Latack, 1986) have emphasised the need to ground such developments firmly in theory. On the other hand Dewe and Guest (1990) have argued that empirical work rather than theory should guide the classification of coping responses. There is clearly a great need for further work in this area. While coping is certainly a complex process, and will remain largely inaccessible without improvements in methodology, it has been suggested by Parkes (1986) that much can still be learnt from taking a traditional and less complex approach to the study of coping as a variable in stress research.

2.3.2 Personality and individual differences

This section is concerned with personality and individual differences as variables which have been used in stress research. A very large number of variables could be placed under this general heading, though the use of this type of variable has been somewhat limited in stress research. The first part of this section describes the general background to and development of personality variables in stress research. The second part will discuss the use of some more recent personality variables in stress research.

Relationships between personality and health have been suggested since the concept of personality was first considered (e.g. see Gatchel & Baum, 1983). In the humoral theory of personality for example, which emerged in ancient Greece, four humours were thought to determine physiological and psychological temperament. More recently, the role of personality in the development of physical symptoms was emphasised by Freud (e.g. 1946). As discussed in section 2.1.1 above, Freud's psychoanalytic approach was later overtaken by psychophysiological interpretations of the relationship between emotion and physical health. While this approach continued to develop within psychosomatic medicine, attention to personality factors generally lessened (Lipowski, 1977), with a few notable exceptions.

Dunbar (1938) for example, extended the psychoanalytic approach by clinically assessing a large number of patients with organic diseases using psychodynamic methods. By these assessments of particular diseases, she formulated a number of disease-personality types such as the coronary personality, the arthritic personality and the ulcer personality (Wittkower, 1977). However, this and other psychoanalytically based personality approaches were not acceptable to many psychosomatic researchers who required evidence of specific psychophysiological mechanisms in order to explain the link between personality characteristics and disease (Lipowski, 1977).

Many of the early approaches were not concerned with personality as a variable in stress research. Rather, their concern was to establish direct links between personality type and disease by using an individual clinical approach. The nomothetic quantitative measurement of personality, rather than idiograpic clinical assessment, makes it more possible to use personality as a variable. Many early studies in stress research using the life events paradigm (e.g. Dohrenwend & Dohrenwend, 1974b) did not use traditional measures of personality as such. However measures of the coronary-prone Type-A personality were frequently used (e.g. Friedman & Rosenman, 1974; Glass, 1977; Minter & Kimball, 1980; Rhodewalt et al, 1984), and remain popular. This personality variable, characterised by, amongst other qualities, intense drive, poorly defined goals, competitiveness, and hostility, is similar in many ways to the coronary personality described by Dunbar some fifty years ago (Eysenck, 1983).

The idea of consistent personality traits is in itself controversial (Mischel, 1968) which may partly explain why such measures have not been more fully adopted, even though their importance is widely acknowledged. Also, the theoretical and causal confusion between coping styles and personality has made personality variables difficult to incorporate into stress research. For example, there is the problem of whether personality traits influence the coping process, or coping responses, when generalized as a style, form a personality trait. Clearly, detailed discussion of such issues is beyond the scope of this chapter, but such issues have undoubtedly influenced the level of use of personality variables in stress research.

Personality variables have not featured heavily in stress research, particularly occupational stress research (Kobasa, 1988). However, other individual difference variables, including cognitive style, traits, and beliefs have received slightly more attention. Two individual difference variables will be discussed, personal control and negative affectivity. These variables have been selected for their broader theoretical and empirical relevance to stress research. Although other individual difference variables such as type-A or hardiness (Kobasa, 1982) could have been chosen, personal control and negative affectivity are in many ways more illustrative of the methodological and conceptual difficulties faced by stress research.

Personal control

Personal control refers to the extent to which an individual has a generalised belief that they are able to control or have influence over the environment. Environmental control on the other hand, refers to the extent to which the environment is controllable, even though, as discussed in section 2.2.3 above, most measures of environmental control ask for the individual's perception of that control. There is considerable evidence that the belief that the environment is controllable can have an influence on health variables (e.g. see Steptoe & Appels, 1989). A distinction is generally made between individuals whose locus of control is external or internal (Rotter, 1966). Externals tend to perceive control as external to themselves and outside in the situation (low personal control), while for internals, control is perceived to come from within (high personal control). This basic distinction is reflected in the measures which have been developed to measure this variable.

Typically, in non-experimental research, control is measured by a fairly short scale which taps very general beliefs about control. This raises a large number of theoretical issues about the status of control as a variable when measured using this method (Frese, 1989). For example, there is the question of whether or not these beliefs represent an assessment of environmental control, and whether the difference is an important one. Secondly, as individuals may differ in their need or desire for control, this dimension should perhaps also be measured so that a more comprehensive meaning of personal control can be gained. A final example is found in the issue of whether individuals have generalized beliefs which do not simply reflect beliefs about control in specific domains (e.g. work, home, family).

Despite these and other problems, a substantial body of evidence exists in support of the relationship between control and health variables. However, some caution is required in the interpretation of these findings as different measures and different conceptualizations of control have been used. Examples of these include mastery (Pearlin et al, 1981) and self-efficacy (Bandura et al, 1982). While there is little agreement over measures and conceptualizations of control, the importance of perceived control as a variable in stress research is widely acknowledged. Control appears to be such a fundamental aspect of nearly all human behaviour (e.g. Lefcourt, 1973; White 1974) that it is perhaps unsurprising that difficulties arise during measurement and operationalisation. Indeed, outside the specific area of stress research, a number of theoretical models of human motivation (e.g. Hyland, 1988; Klein, 1989), behavioural self-regulation (Scheier & Carver, 1988), and emotion (Weiner, 1986) are based on control theory, attesting to the pervasiveness of control as a theoretically powerful construct and a central feature of human behaviour.

In the last few years, measures and conceptualizations of control have tended to move away from the idea of control as a generalized belief. Instead, distinctions between different kinds of control in specific areas are more commonly made. For example, Cohen et al (1986) describe four major types of control: behavioural, cognitive, decisional, and retrospective. Also, Ganster (1988) distinguishes between the direct, indirect and moderating effects of control in the workplace. However, these theoretical developments have not as yet been matched by empirical work using measures based on such distinctions. Using more sophisticated measures could help to untangle some of the complex relationships between control and health. The study of related individual differences, such as optimism and pessimism (Dember et al, 1989; Peterson et al, 1988), may likewise make the status of this variable in stress research clearer, in both theoretical and empirical terms.

Negative affectivity

The idea of negative affectivity as an individual difference variable is relatively new (Brett et al, 1990; Brief et al 1988; Watson & Clark, 1984; Watson & Pennebaker, 1989), although it is in many ways similar to trait anxiety or neuroticism (Costa & McCrae, 1980, Payne, 1988). Within stress research, both negative affectivity and trait anxiety have only recently begun to be studied as individual difference variables. Unlike most of the other variables discussed, the impetus for measuring negative affectivity is not its theoretical importance to models of stress. Rather the variable is measured to overcome the methodological problem of chronic disorder in the interpretation of stress research findings. The fact that some individuals may experience and/or report chronic levels of psychological symptoms quite independently of environmental changes is theoretically unimportant to stress research, but is of vital importance if studies fail to take account of such a phenomenon.

Negative affect, as conceptualized by Watson & Tellegen (1985), is the extent to which someone "reports feeling upset or negatively aroused" (p. 221). Negative affectivity refers to a trait in which there is a persistent experience of negative affect. A number of studies have shown that this variable is positively related to symptom measures (Brief et al, 1988; Watson & Pennebaker, 1989), a number of personality traits (Watson & Clark, 1984), and life events measures (Brett et al, 1990). There are relatively few difficulties in measuring negative affectivity, but a number of difficulties exist in interpreting the mechanisms by which high negative affectivity is associated with higher levels of symptom reporting. It could be argued that such difficulties are not particularly important if negative affectivity is only what has been described as a "methodological nuisance" (Brief et al, 1988, p. 193). However, in the present context these difficulties are important, irrespective of how negative affectivity as a variable is used in stress research, because the mechanisms by which negative affectivity operates will determine if and how it can be used to remove 'noise' from symptom reports. These mechanisms will also influence how negative affectivity relates to other variables.

Negative affectivity is not only correlated with symptom reports, but also with perceived stress (Watson, 1988). The first of these associations is open to a number of interpretations. Watson and Pennebaker (1989) suggest three mechanisms whereby negative affectivity may be associated with higher levels of symptom reports. In the first, described as a version of the classic psychosomatic hypothesis, negative affectivity directly causes health problems because it involves high levels of anxiety and depression. The second mechanism is described as the disability hypothesis, as in this case it is suggested that prolonged health problems actually cause negative affectivity. Third, it may be that individuals who experience negative affectivity pay more attention to, and/or are more aware of bodily sensations. Watson and Pennebaker (1989) found that in general negative affectivity was not associated with actual long-term health status, but was correlated with self-report health and symptom measures. Controlling for this variable does lower the correlations between stress and strain measures (Brief et al, 1988).

The second association, between perceived stress and negative affectivity calls into question the role of negative affectivity as a 'control' variable in stress research. If negative affectivity only influenced symptom measures, its contaminating influence could be removed. However, its influences on the perception of the stressfulness of environments and events means that negative affectivity "may not be just a psychometric bother in job stress research, but, rather a theoretical variable with which to be reckoned" (Brief et al, 1988, p. 197). Individuals who experience negative affectivity may view their lives as inherently difficult regardless of what happens to them, or they may find it difficult to manage themselves and their environments (Watson, 1988). The difficulty in interpreting the influence of negative affectivity underscores the complexity of the relationships between environmental and health measures. It is likely that this trait will assume increasing importance in stress research.

The current status of individual difference variables

It has been suggested by Cohen and Edwards (1989) that drawing firm conclusions about the effects of these variables is made difficult by a shortage of "methodologically competent, conceptually sophisticated research" (p. 275). Although the use of individual difference variables in stress research may assume a greater importance, considerable caution in their use and interpretation is required if the constructs underlying such variables are to be incorporated into theoretical models of stress. Without such caution, the present the status of individual difference variables may be reduced to one of a control variable, with little theoretical importance within stress research. However individual differences are conceptualized, they clearly relate not only to symptom reporting, but to perceptions of the environment, to coping processes, to social support, and in fact to most of the variables discussed in this chapter. While individual differences can be viewed as a nuisance in stress research this nuisance extends far beyond the statistical and methodological, to question the theoretical foundations on which the concept of stress and the idea of individual differences rest.

2.3.3 Well-being

Stress research is characterised by the use of a wide range of independent variables (such as life events or job characteristics), and a large number of variables which are thought to be moderators or mediators (for example coping or individual differences), yet only one general category of dependent or outcome variable is used, well-being. Most stress research is concerned either directly or indirectly with those factors which contribute to low levels of well-being or physical or psychological disorder. In contrast to conceptual and methodological development and differentiation in the measurement of independent and moderating or mediating variables, the dependent variable, far from undergoing development and differentiation, has developed little and has become less differentiated (Depue & Monroe, 1986).

For example, in many studies of stress general non-specific self-report indices of symptoms are used, from which a total score of disorder is calculated. The individual and clinical approach to stress and illness, adopted by early psychosomatic researchers and those studying coping (see above) not only used quite specific measures of disorder, but often studied the development of particular syndromes or diseases as well as the personality characteristics associated with them (e.g. see Wolf, 1953). In addition, epidemiological approaches to stress and disorder tended to examine the incidence of particular diseases in relation to, say, life events and job characteristics. Even where indices of symptoms were used, attempts were made to differentiate between different syndromes, or between different bodily systems (e.g. respiratory, gastrointestinal, cardiovascular) in an attempt to discover the patterns of association between environmental stress and specific syndromes (e.g. Hinkle, 1974).

Since the use of large-scale, often cross-sectional studies in stress research, measures of disorder have become less differentiated (Depue & Monroe, 1986). While studies of specific disease have been conducted (e.g. coronary heart disease), these have been somewhat narrowly focused, and therefore limited in their usefulness and impact on general stress research. It is unclear exactly why non-specific measures of psychological symptoms such as the General Health Questionnaire (Goldberg, 1972) and non-specific measures of physical symptoms have come to be so widely used in stress research. One possible reason for this could be the fundamental research question which drove many large-scale surveys in stress research: Does stress cause illness? In general, the findings from such research showed quite a low association between measures of stress and measures of disorder. The weakness of this association seems to have been blamed almost entirely on the methodological and theoretical inadequacy of the independent, mediating and moderating variables. Well-being, or the absence of illness as a dependent variable was seen as a relatively simple concept, whereas the complex nature of stress was more apparent.

Whatever the reasons for this trend towards non-specificity in the measurement of disorder in stress research, a number of methodological problems with such measures are apparent, which have only received critical attention in fairly recent years, in particular from Depue & Monroe (1986). They have suggested that approximately 25% of different types of populations experience chronic levels of disorder as assessed by non-specific measures of symptoms, which may explain why only relatively weak relationships are found between such measures and measures of stress. One reason for chronic symptom reporting, as discussed above, may be individual differences in negative affectivity. However this group may also be composed of those who display psychopathological disorders, those who are chronically physically or mentally ill, and those who experience prolonged life difficulties (Depue & Monroe, 1986).

Perhaps then, a simple solution to the drawbacks of non-specific measurement is to make them specific, and also more objective. However, in making them more specific or objective a number of difficulties in interpretation will arise, mainly due to the inadequacy of existing models of the relationship between stress and illness. These models will be discussed in the next chapter. Here, some examples of these difficulties will serve as illustrations. First, current models of stress and illness may not account for the effects of stress on those in the population who experience chronic disorder (Depue & Monroe, 1986). Second, as subjective measures of disorder may still be important as a variable in stress research, the problem remains of how can these be related to more objective measures of disorder, and to existing models of stress. Third, assessing specific disorders may well prevent the development of general models of stress and illness, as many researchers believe that the relationships between stress and illness will depend on the specific disorder (e.g. Depue & Monroe, 1986; Mason, 1971). A final example involves the measurement of environmental stress. If measures of specific disorders or syndromes are obtained, then it is likely that the measurement of environmental variables will have to become more sophisticated, as different disorders are likely to be associated with quite different stressors, such as types of life events, hassles, or workload, which are not as yet sufficiently differentiated.

Partly as a result of the inadequacy of non-specific indices of disorder, and partly as a consequence of asking more specific and more detailed research questions, other measures of well-being are beginning to be used more widely. Two of these will be briefly discussed here: affect and physiological measures.

While disorder as an indicator of well-being has received little theoretical or methodological attention, the measurement of affect has been the subject of a great deal of research in recent years (e.g. Diener & Emmons, 1984; Watson, 1988; Watson & Tellegen, 1985). As a variable in stress research, daily measures of affect have been used in a number studies of minor hassles (e.g. Bolger et al, 1989; Clark & Watson, 1988; DeLongis et al, 1988; Stone, 1987). A range of physiological indices, including heart rate, blood pressure (e.g. Smith et al, 1989), biochemical indicators such as catecholamines (see Fried, 1988), and measures of immunocompetence such as immunoglobulin (Antoni, 1987; Stone et al, 1987a, 1987b) have also been used. Many of these studies have observed the changes in measures in relation to daily hassles or between experimental conditions.

There are a number of methodological issues in the measurement of both affect (e.g. Diener & Emmons, 1984; Watson, 1988a) and physiological indices (e.g. Fried et al, 1984). However, a more serious problem is relating short-term changes in physiology (Scheuch, 1986) to longer-term health outcomes. Recovery and 'unwinding' processes are crucial for an understanding of this relationship (e.g. Frankenhaeuser, 1981). A similar difficulty can be found in understanding the relationship between short-term affective responses and longer-term health.

Despite these potential difficulties, measures of well-being in stress research are moving away from non-specific indices of symptoms towards more short-term measures of affect and physiology. It is likely that given the complexity of the relationships between short-term physiological and affective changes and long-term health outcomes, and objective specific, and subjective non-specific measures of disorder, a much wider range of measures will be used.

2.4 Discussion and conclusions

This chapter has considered the development of some of the constructs and variables currently used and measured in stress research. Although theoretical models of stress have not yet been discussed, a number of implicit models have emerged. A description of the way in which variables are measured often gives a strong indication of why the variable is being measured. Discussion of explicit models and theoretical frameworks in stress research will take place in the next chapter.

This chapter has attempted to clarify the phenomenon of stress by examining the components of the phenomenon. These components have been described and examined by looking at their development and operationalization as variables. There are clearly a large number of components within the phenomenon of stress. For this and other reasons a number of researchers have suggested that stress is not, and should not be conceptualised as a single phenomenon. Efforts to make research more sophisticated have been constrained by a number of factors. These include the simplicity of outcome measures, the narrow focus of much stress research on demonstrating links between stress and health, and inadequate attention to theoretical issues such as the scope or complexity of the phenomena under study.

This latter constraint can be observed in the measurement of almost all variables in stress research. Many of these variables and their underlying constructs were initially measured and conceptualized in a relatively simple way. As stress research has developed, these variables and constructs have increasingly become subjected to methodological and theoretical scrutiny. Under this examination most have appeared to be inadequate. They are easily confounded and confused with other variables, and show themselves to be considerably more sophisticated and complex than their measurement suggests. The nature of a phenomenon whose components and relationships between them are confused and unclear (and remain so even after careful examination) must be considered. A characterization might be that it is one which has persistently been examined in an over-simplistic way; that the phenomenon or more likely the phenomena are more complex than the predominant level of analysis suggests.

While many phenomena are over-simplified in order to study them, such a strategy is perhaps more comprehensible in a situation where advances in understanding and new discoveries are made. This has not been the situation in stress research. The question remains then of why it should be the case that researchers persistently over-simplify the phenomena they are studying. One reason for this is a lack of theory, and this fact in itself requires some explanation. Although theory will be discussed explicitly in the next chapter, it is apparent from the discussion of variables that theory is not well developed. Poor measures and weak theory are mutually reinforcing; they enjoy a symbiotic relationship. One way of finding out why there is a lack of theory is to ask why researchers study stress. The use of measures of general health as almost the only dependent variable of interest would suggest that the motivation, or at least the rationale for studying stress is to study general ill health. In order to effectively follow this rationale the relationship between stress and disease must first be established (which perhaps explains the seemingly endless attempts to replicate basic findings), and second a general model of health must be adopted.

This model, which depicts characteristics of the environment and characteristics of individual as producing individual health and disease, underlies the difficulties encountered when attempting to locate stress as a phenomenon, or to understand when and how it occurs. In medical research, which may also use this model, the outcome variable is often the appearance of a particular disease rather than general levels of ill health. In the context of a specific outcome it is easier to make distinctions between cause and effect, and environment and individual. Indeed, it has been argued that the relationship between stress and disorder can only be understood by examining specific disorders (Depue & Monroe, 1986).

While the outcome variable remains very general, what stress research attempts to study is actually a phenomenon or collection of phenomena which are more accurately described as adaptation: More specifically, physiological and psychological adaptation which operates in different kinds of loosely connected systems, over time periods of seconds, minutes, hours, days, and/or years. If the word stress were to be replaced by the word adaptation, it would be nonsensical to attempt to establish if adaptation is a stimulus or a response, or if adaptation affects some people more than others. The phenomenon itself spans the boundaries of stimulus and response, and the person and the environment. (This theme of stress as adaptation will be taken up again and expanded upon in Chapter 3.) In the measurement of variables and the design of studies, individual researchers have made simplistic attempts to study a relatively small part of a large and presumably complex collection of processes. It is unsurprising therefore, particularly in the absence of theoretical models of such processes, that researchers' efforts have been severely limited.

The reasoning behind this chapter was to examine the components of a complex phenomenon, before examining how the components interact. This was done with the intention of facilitating a clearer understanding of the phenomenon. But unlike the mechanistic phenomena on which this reasoning is based (such as a car engine), it would appear that there is little agreement on the structure or the components of the phenomena, and furthermore how the existence and operation of such components can be established. Whilst this reasoning has not perhaps led to a direct clarification, is has enabled an account to be offered of why the phenomena of stress is difficult to clarify.

2.5 Summary

One approach to the analysis of stress is to consider the variables which are typically measured in stress research, and to do so separately from a discussion of theories which attempt to explain the relationships between these variables or components. A large number of variables are measured in stress research. Only those used in the empirical research in this thesis or are otherwise of particular importance in the development of theory were discussed. Before such a discussion, an informal model of health and disease, on which stress research is often implicitly based, needed to be described. The model simply stated that characteristics of the individual and characteristics of the environment combine to produce individual health and disease. The discussion of variables used this framework as a structure, although there are some general theoretical problems in making distinctions between the person and the environment.

Taking environmental variables first, three classes of such variable; life events, environmental characteristics, and job characteristics play a central role in stress research. The popularity of life events measures in stress research has declined as a result of an increasing awareness of the importance of other variables, and a rejection of the simple cause-effect, stimulus-response model of stress and health which life events research often implies. With the exception of social support, environmental characteristics have not been widely studied, though they are assumed to be important. Job characteristics have been studied more intensively, though it is only in the last decade or so that measurements of job characteristics have been used in stress research. In particular, measures of workload and control have been used to predict occupational health outcomes. These latter measures are theoretically and methodologically somewhat underdeveloped. In particular, the measurement of objective and subjective job characteristics is often confounded.

Variables located in the individual can be considered under three main headings: Individual coping, personality and individual differences, and well-being. While the concept of coping has been developed theoretically for some time, measures of coping are relatively new. Difficulties have arisen in developing measures which represent and reflect the complexity of coping. Also, traditional research designs preclude adequate assessment of coping as a transactional process.

A large number of individual difference variables have been used in stress research. Personality variables have been used less than other individual difference variables such as cognitive styles and beliefs. Beliefs about personal control feature heavily, though there is little consensus in theory or measurement. The fundamental importance of control in all human behaviour has led to the use of measures which tap general beliefs, though it is now recognised that more specific measures and differentiation between types of control are required.

Another individual difference variable, negative affectivity, is relatively new to stress research. This measure is generally not used for its theoretical importance, but more as a result of methodological difficulties in the interpretation of the relationships between measures of stress and measures of health, particularly where a large proportion of the population may report chronic levels of disorder as a consequence of negative affectivity. The importance of individual difference variables is widely recognised, though there are a number of difficulties in incorporating these variables in stress research.

The third type of variable which can be located in the individual is well-being. In contrast to the large range of independent and moderating variables measured in stress research, well-being is usually the only dependent variable used. The predominant use of non-specific indices of disorder has, in the last few years, been severely criticised, with some researchers moving towards more specific measures, and measures of different dimensions of affect.

The examination of the components or the variables in stress research has not perhaps led to a direct clarification of the phenomena of stress. This examination has showed that when the individual components are described in detail, and are the subject of close scrutiny, they become less distinctive and more confounded. The way in which these components are conceptualized is over-simplified, and the nature of the relationship between them is difficult to specify.

CHAPTER THREE

THEORETICAL AND METHODOLOGICAL ISSUES AND A RATIONAL FRAMEWORK FOR THE INTERPRETATION OF STRESS PHENOMENA

3.0 Introduction

The previous chapter discussed and reviewed the methodological development and measurement of some of the variables in stress research. This chapter moves on to an analysis and synthesis of some of the theoretical and methodological issues in stress research. This will take place in four stages in sections 3.1 - 3.4. First, the implicit theory underlying the measurement of variables will be discussed. Second, explicit theories, and their relationship to implicit theories of stress, will be examined. Third, by using a rational approach to theory building in stress research, a synthesis of various theories, from within and outside traditional stress research will be developed in order to generate a theoretical framework. Fourth, some of the methodologies which arise from this framework will be discussed.

3.1 Implicit theory in methodological and empirical practice

This section will discuss theories of stress phenomena which are implicit in the issues raised in the previous chapter, and which can also be observed in the links between the historical background described in Chapter One and contemporary issues in the measurement of variables. This will proceed by considering a number of general questions which could be asked about stress. These questions will also act as headings for the discussion. In Chapter One it was argued that for complex phenomena, such as stress, it is often clearer if its components or parts are specified before examining how these parts interact. This section will examine the ways in which the specification of these components has helped (or not) to clarify the phenomena of stress.

3.1.1 The whys and hows of stress

Whys and hows refer to theoretical models or explanations of stress. In section 2.2 an informal medical model of health was presented in which characteristics of the individual and characteristics of the environment combine to produce individual health and disease. The way in which this chapter has been organised obviously reinforces these ideas. However, certain aspects of the historical background and the development of variables in stress research also reinforce this model, as do the parallels between medical research and stress research.

According to this model, exactly why and how stress operates is the same as, or very similar to, why and how any particular factors operate to affect health. A number of examples can demonstrate these similarities. First, as in medicine there is a strong emphasis on illness, rather than health. So-called protective factors (such as social support) are also included, but the emphasis remains on the notion of the individual receiving protection from illness. This view is reflected quite explicitly in the idea of stress-inoculation training (e.g. Meichenbaum, 1985).

A second example, in which illness is again emphasized, involves the view that stress, in a similar way to a virus, is seen as a straightforward, external, and relatively direct threat to health. This view persists even though debates, such as those in life events research, about whether it is change per se or only negative change which is harmful, and a recognition of the potentially harmful effects of social interaction (e.g. Abbey & Rovine, 1985; Rook, 1984), suggest that the relationship between stress and health is more complicated.

Third, like most new theories of disease, stress has been studied as a causative factor to the exclusion of almost all other causative factors, such as nutrition, poverty, health behaviours, and genetic predisposition. Non-specific indices of disorder help to encourage the simple view that stress causes disease. An analogy can be drawn with the history of the germ theory of disease, in which all diseases were thought to be caused, or influenced by germs.

A final related example involves the enthusiasm with which these single-factor theories of disease are studied. Not only are other factors generally omitted from studies, but a great deal of effort is expended in attempting to demonstrate the importance of the single factor even when the associations between that factor and disease are weak. In stress research, the rationale for the methodological development of existing variables, and the inclusion of new variables, has often been to increase the strength of the associations between measures of stress and measures of disease.

The informal model of health has then been reinforced by theory and practice in stress research. While specific variables such as coping or social support do have relevance to other areas of research, the emphasis remains firmly on health and illness as the most important reason for the study of such variables. It is ironic that most stress research adopts a medical model of illness by focussing on a relatively narrow range of explanatory variables when the initial impetus of early psychosomatic researchers was to move away from simple physical and dualistic models of illness. This more holistic approach recognised the importance of both psychological and physical factors in illness and health, and even deliberately blurred the distinction between the two. In contrast to these holistic traditions, stress research has become increasingly narrow in its approach, attempting to demonstrate that stress must, or should be, a causative factor in illness.

A further source of implicit theories of stress can be found in the popular use of the term. Although this has not been discussed in Chapters One or Two, public opinion and policy clearly influences researchers, and therefore the topics they study. While a discussion of these issues is beyond the scope of this thesis, it should be noted that in the last decade or so there has been a large increase in public awareness of the idea of stress. For example, stress-management courses and self-help books are now relatively commonplace, and posts for clinical psychologists who specialise in stress management have been created in health authorities. The idea of stress may be invoked as part of a legal defence, and used as a symptom descriptor, in much the same way as 'nerves' perhaps used to be. The idea of stress has gained a great deal of currency in popular language (e.g. Ursin & Murison, 1984) and can be used to 'explain' illness and neutralize or objectify emotions. Although lay theories of many phenomena exist, it has been suggested that stress is a modern myth which is used by both stress researchers and the general public in a mutually reinforcing way (Pollock, 1988). Another implicit theory of stress is the one that researchers and the public may share, as a new threat to health.

The whys and hows of stress discussed here have been limited to those which can be observed from the historical background to, and from an analysis of the variables typically measured in, stress research. They represent very simple, theories of stress which are perhaps no more than descriptions of phenomena rather than articulated explanations.

3.1.2 <u>What is stress?</u>

This question is asked so often, and directly answered so infrequently that it has almost become a self-parodying reflection on the state of stress research.

Even in popular books on stress, the answer to the question 'what is stress?' usually begins by explaining that it is difficult to answer because there are so many definitions, or that it is an extremely complex phenomenon (e.g. Ecker, 1985; Fontana, 1989; Meichenbaum, 1983). Apart from definitional problems which arise from stimulus-response models of causality, a more powerful source of definitional difficulty is an implicit analogy which runs through the measurement of many variables in stress research; the engineering analogy.

This analogy provides a ready-made and superficial answer to the question 'what is stress?'. In engineering, the word stress is used to refer to a force or load placed upon an object and the word strain refers to deformation that may result in the object. The extent to which deformation occurs depends on a number of factors, including the load placed on the object and the strength of the material. The use of this analogy is sometimes quite explicit, but even where it is not, its influence is clear. For example, the terms workload and social support imply an almost physical load, and a physical support. Also, some individual differences are described as buffering the impact of stress, and others, such as hardiness describe the strength of the material. This analogy strongly influences the way in which variables are conceptualized and measured. Although it does provides a simple and obvious framework for considering their interrelationships, it places severe limitations on the way stress, as an idea, is operationalized.

One limitation of the engineering analogy can be observed in the attempt to use it to conceptualise stress and strain as independent variables, which often fails, both theoretically and empirically. Variables such as life stress or life events can be influenced by levels of strain. A second, related limitation is that this analogy encourages the view that variables in stress research, like those in engineering, can and must be measured as objectively as possible.

Clearly some variables can be measured in a relatively objective way, but as discussed earlier, it is unclear for many variables (such as workload or social support) what such objectivity means in terms of the mechanisms and processes involved. Third, this analogy makes individual difference variables properties of the person, like the properties of a material. However many of these variables are difficult to conceptualise as being fixed in the individual as they operate by influencing other processes such as coping. While they may be thought of as individual differences, like differences between the physical properties of materials, they operate through processes which cannot be placed neatly in the internal structure of the individual, unlike the differences in the properties of materials.

The engineering analogy is not only too simple, but may also be inaccurate, no matter how sophisticated our understanding of mechanics. It would seem to explain little and imposes limitations on the way in which variables are measured or conceptualized, and limitations on the possible interactions between them.

Another answer to the question 'what is stress?' is often understood in terms of what stress is supposed to do, that is, cause illness: Stress is what stress does. For example, it is common to speak of one occupation as more stressful than another, or a high stress group and a low stress group in experimental conditions. Membership of these groups is usually defined by the level of symptom reports. This is not a simple confusion over definitions, or sloppiness in the use of language. It reflects the belief that stress is not only the main cause of higher symptom reporting, but also that stress and symptom reporting are synonymous. This belief persists even though empirical evidence is weak, and the subject of controversy (e.g. Maddi et al, 1987; Rabkin & Struening, 1976; Schroeder & Costa, 1984). Using the term 'strain' does not remove this problem as the underlying assumption remains the same, namely that stress causes strain or symptoms. The points made in the above section concerning the interpretation of stress as a modern myth could be repeated here. A functional analysis applied to the question 'what is stress?' would yield similar answers: Stress is not a phenomenon in itself, but an important part of lay, scientific, and medical belief systems.

The suggestion by Lazarus (1966) that stress is a rubric or a general heading for an area of study supports the view that stress is not a single phenomenon. It is difficult to understand why researchers even attempt to define stress as a phenomenon. A parallel would be an attempt to define psychology or sociology as a single phenomenon, rather than as an area of study.

Another answer to the question asked in this section concerns the general notion that stress is a 'bad' phenomenon. It is clear from the discussion which has taken place that stress is regarded as a negative influence on health and therefore a wholly negative phenomenon. However, in both popular accounts and according to Selye (1956), stress is viewed as a central part of human experience such that there can be 'good' stress (eustress) as well as 'bad' stress (distress). Once again, the almost synonymous relationship between stress and health tends to dominate answers to the question of what stress is.

3.1.3 Where is stress?

The answers to the question 'where is stress?' fall into three main categories. Throughout this chapter, stress has been implicitly (and sometimes explicitly) described as either a phenomenon external to the person (a stimulus), as a response within the person, or as a phenomenon which is located at the junction between the person and the environment as some form of interaction. Each of these categories of description will be discussed in turn.

Stress as a stimulus

Locating stress outside the person is the most common way of answering the question 'where is stress?'. As discussed in the previous section, this is partly the result of the influence of the engineering analogy, but also the influence of germ theories of disease. In general, much more attention has been given to the development and measurement of stimulus variables (such as life events or workload) or variables which moderate this stimulus (such as social support or personality) than response variables. The clearest example of the conceptualization of stress as an external stimulus can be found in the life events approach to the measurement of life stress. Within this approach stress is very much 'out there' in the environment and life events are, on the whole, considered to be events which happen to people rather than events over which people have some causal control.

The idea that stress is 'out there' in the environment, and that life events, such as moving house or changing jobs, are stressful has a great deal of intuitive appeal. However, further appeals to intuition also suggest that stress may not be as environmental as the life events model implies. Life events can be thought of as not outside or not wholly external to the individual when and if the individual actually plays a part in making such events happen. For example, changing jobs can only be thought of as an external, environmental change if the individual has little control over or knowledge of that event. If, for example, the individual seeks to change jobs or knows exactly when a job change is likely to occur it becomes difficult to maintain a model of stress as either exclusively environmental, or as a discrete stimulus. These problems are recognised by many life events researchers who, as discussed in Chapter

Two make distinctions between undesirable and desirable, or controllable and uncontrollable life events.

As discussed in section 2.3.1. the life events approach to stress has been criticised for attempting to objectify stress as an external event (e.g. Lazarus et al, 1985). The attempt to externalize stress is part of a larger effort to objectify its measurement, and to impose a stimulus-response model on the phenomenon. Life events measures have been described as "methodological expedients" (Kessler et al, 1985, p. 539), which have little theoretical foundation. The same criticisms could perhaps be levelled against all conceptualizations of stress as an external environmental phenomenon, though some events, such as unexpected bereavement, fit this model quite well. To suggest that some types of stress can be placed in this in it would seem to be unproblematic. However, a model which places stress exclusively in the environment is difficult to support.

The inclusion of variables such as coping, or individual difference variables such as negative affectivity in studies of stress suggest that the individual can determine to some extent what is 'out there' in the environment. The way in which an individual responds to, or perceives the environment means that environments are not equal for all individuals, even when certain types of measurement tell us that they are equal.

This debate has many parallels with the discussion in 2.3.3. of the objective versus subjective measurement of job characteristics such as environmental control and workload. As for the measurement of these variables, it could be argued that stress should be measured as an external 'objective' stimulus as well as internal 'subjective' response, or perception of the environmental stimuli. What becomes more critical in this case is the relationship between the objective and subjective measures rather than attempting to establish which type of measure is most accurately measuring stress.

Beyond measurement issues remain the difficulties in answering the question 'where is stress?'. The predominant impression given from the way most variables are measured, including environmental and individual variables is that stress is an external stimulus. Even where individual responses are viewed as important in determining outcomes, they are still conceptualized as responses to an external stimulus. The engineering analogy seems to constrain other conceptualizations of stress. While social support continues to 'buffer', and an individual's hardiness protects them from something 'out there', stress will be conceptually cast in the role of an environmental stimulus.

Stress as a response

While the measurement of some variables gives the impression that stress is a stimulus, the measurement of coping implies that it may be a response. Inasmuch as stress can be said to occur when coping occurs, it is the response to a stimulus, rather than the stimulus which is thought of as stress. Rather than being 'out there', stress is 'in here', as an internal response of the individual. In addition to coping, the measurement of some physiological variables also implies that stress is a response more than it is a stimulus. The idea of stress as a response can be traced back to two parts of the historical background to stress research: Stress as a biological/physiological phenomenon, and stress as a precursor or catalyst to psychological adaptation.

Biological/physiological ideas of stress such as Selye's (e.g. 1956) clearly defined stress as a physiological response. Although definitions from the area of psychological adaptation were less uniform, the predominant view was of stress as an internal response within the individual. In the measurement of coping and physiological indices, these perspectives continue to be influential, though a greater awareness of the distinction between stress and strain is perhaps apparent. If the individual responds by coping, or responds physiologically, stress can be said to be present. If the individual is not engaged in coping, or responding physiologically, then within this framework stress is not present. Without a stimulus there can be no response, but response-based answers to the question pay little attention to the nature of the stimulus, though it is assumed to exist.

In the case of both psychological and physiological response-based answers, the response to a stressful stimulus is viewed as the starting point for further investigation. In a sense, the initial response is viewed as a stimulus for further physiological or psychological responses. For example Lazarus's model of coping (e.g. 1966) takes primary appraisal as a response which then becomes a stimulus for secondary appraisal processes.

Both the stimulus and response-based answers to the question 'where is stress?' tend to place it firmly in the environment or in the individual. Although response-based approaches may include the idea of a process which may, in the case of coping for example, lead to responses which influence the environment, the location of stress remains within the individual.

Stress as an interaction and transaction

Interactional and transactional approaches answer the question by suggesting that stress cannot be clearly located in the person or in the environment, but at the interface between the person and the environment. In many ways this reflects a medical model of disease wherein properties of the person (e.g. individual vulnerabilities) and properties of the environment (e.g. bacteria) interact to produce disease. Whatever produces stress, and wherever stress originates from, it cannot be located exclusively in the environment or in the person. While both interactional and transactional approaches are discussed here, they differ in a number of important respects. For this reason, each approach will be discussed in turn.

An example of an interactional approach is the view that individual difference variables influence the impact of, or response to environmental stimuli. In an interactional approach the ideas of stimulus and response and environment and individual are used without difficulty. The interactional approach is implied by the measurement of most moderating and mediating variables in stress research such as environmental control, or social support. However, it is not entirely clear if the interactional approach is a firm theoretical stance or a methodological/statistical convenience. It may be based more on an acknowledgement of and response to the difficulties involved in locating stress exclusively either in the environment as a stimulus or in the person as a response.

The transactional approach on the other hand is more than an acknowledgement of difficulties involved in limiting the location of stress. It suggests that stress cannot be located in the environment or in the individual, and furthermore, that the fixed categories of environment and individual, and stimulus and response, do not, as they are currently formulated, make sense in stress research. Direct examples of this approach appear infrequently in the discussion of variables in this chapter, as most variables are measured within a traditional stimulus-response, cause- effect model. However, the confusion and confounding in the measurement of many variables, hints of some of the issues which underlie a transactional approach.

Whereas the interactional approach could be described as a convenient description of the way in which variables in stress research interact, the transactional approach is meant to represent the way in which phenomena in the world interact. The debate surrounding the measurement of life events or life stress in section 2.3.1. focuses on many of these issues. For more traditional life events researchers, stress is an external objective stimulus. This conceptualization leads to the measurement of stress as a relatively pure environmental stimulus. More recent approaches, exemplified by Lazarus et al (1985) suggest that it is not possible to clearly separate stimulus and response, or cause and effect. If measurement confounds stimulus and response it is because phenomena in the world are confounded: Phenomena do not always fall neatly into the categories we devise.

This goes further than the interactional approach which would accept that life events are an environmental stimulus which is somehow moderated or mediated by individual characteristics and responses. Conversely "...transaction implies a newly created level of abstraction in which the separate person and environment elements are joined together to form a new relational meaning" (Lazarus and Folkman, 1984, p. 294). Within this approach, the precise location of stress is rather a moot point. It begs the question of why stress should have a location at all. If the individual and the environment are not separable categories, then stress cannot be located in either, or at the interface between them. If these categories are not separable, a major problem is how relationships between variables can be observed if stimulus and response, or cause and effect, blend into each other.

A solution offered by Lazarus and Folkman (1984) is to focus on processes within stressful encounters rather than studying the structural relationships between variables using cross-sectional designs. This solution suggests that stress cannot be clearly located, as it is a process, rather than a single phenomenon.

3.1.4 When does stress happen?

From the discussion of the variables in stress research in this chapter, the answer to this question in terms of its frequency would appear to range from some of the time to all of the time. The answer to the question in terms of the time period over which the processes in stress act can range from seconds or even milliseconds to days, weeks, years or a lifetime. The answer to this question for both these dimensions of time depends very much on how variables are measured. Are variables measured as discrete stimuli or responses or continuous situations or conditions? For example, a discrete stimulus could be a life event, and a discrete response could be the development of a particular disease. A continuous situation might be low environmental controllability, and a continuous response might be a low score on a general measure of psychological well-being.

With discrete measurements it is possible to consider that stress may be switched on or off depending whether or not a particular criterion has been reached. For continuous measures, stress cannot be switched on or off, but will simply be at different levels, from say 'low' stress to 'high' stress.

As with the question 'where is stress?' the answers to the question asked in this section do not appear to be based on any particular theory of stress, but more on the nature of the measures used, particularly outcome measures, and the design of studies. For example, in cross-sectional research using measures of workload and environmental control, stress is not assumed to be either on or off, but acting either more weakly or more strongly depending on the combination of each variable an individual might report. (But for statistical reasons any sample may be split into low and high groups.) However, the time periods of the processes involved are not particularly clear in such studies, and a number of questions remain unanswered and unanswerable by these methods. For example, there is the question of whether low controllability and high workload have effects on the individual every day, or every minute in the day, or whether it only begins to have effects over a longer time period. Such questions are perhaps unimportant in cross-sectional studies. For more recent studies which use different methodologies, such as measures of daily hassles and affect, these questions are extremely important.

One important consequence of these different research interests is that the relationship between chronic and acute stress, or discrete and continuous variables is rarely examined. A number of research questions illustrate this: Is high workload best conceptualized as a chronic environmental state, or as a series of acute episodes of high workload? Are reports of chronic levels of low psychological well-being related to acute episodes of physical or psychological illnesses? How do discrete stimuli such as life events affect levels of other continuous variables such as the level of social support, or personal control?

The time periods involved in stress implied by the measurement of variables remain confusing. The question of the frequency of stress, or how often stress occurs, depends largely on the outcome measures being used and the criteria used to determine if stress is present. There may be general agreement about the issue of frequency. Although variables are measured in discrete ways, this may be more for reasons of methodological convenience than theoretical importance. The time over which the processes involved in stress act is however a more critical issue, particularly where we wish to establish the relationships between environmental and individual variables and health outcomes. How and what to measure, and when to measure depends on the time scales over which the processes involved are operating.

3.1.5 Who experiences stress?

The answer to this question implied by the measurement of variables in stress research is that almost everyone experiences stress. Particularly, as discussed in the above section, if stress is thought of as a continuous process, or as arising from common experiences. The normative thrust behind life events measures for example assumes that stress is a common experience. Life events inventories are designed to measure the occurrence of those events which most people will experience, such as moving jobs or house, bereavement, and changes in family circumstances. Also, if stress is defined not in terms of health but in terms of disease or illness it becomes possible to suggest that everyone experiences stress because it is assumed that everyone will experience illness at some time.

In addition to this impression that no individual can 'escape' from stress, the measurement of individual differences implies that individuals with higher vulnerability (e.g. those who display Type-A personality) will experience the effects of stress more than others. However, the measurement of some, but less commonly measured, individual difference variables such as hardiness, or those which suggest increased protection or inoculation, imply that some individuals will experience the effects of stress less than others.

For most individual difference variables, which imply greater vulnerability to the effects of stress, the mechanisms by which they increase vulnerability are not made clear. For example, is it the case that high levels of negative affectivity cause higher levels of psychological ill health independently of environmental variables? If so, then such variables cannot be described as a measurement of the vulnerability to the effects of stress, but more a predisposition to chronic psychological ill health.

Whatever the mechanisms by which individual differences operate, the nomothetic and the idiographic components of the answer to this question are clear. On the one hand everyone experiences stress, but on the other some individuals have a higher vulnerability or predisposition to the effects of stress. Despite these two kinds of answers, the general approach implied by the measurement of variables in stress research is nomothetic. Stress is something which everyone experiences throughout their working and non-working life.

3.1.6 Summary and conclusions: Implicit theory in stress research

When methodological and empirical practice is examined, the existence of a considerable number of implicit theories in stress research is apparent. In addition to being numerous, these theories are powerful in their ability to influence research practices. This power is heightened by the fact that these theories are implicit, and remain unquestioned, and unchallenged, and hence exert their influence in subtle ways.

The first theory, considered under the whys and hows of stress, is an informal medical model of health, or more accurately disease. This model strongly influences the conduct of, and equally importantly the rationale for stress research. The common justification given for studying stress is that stress is related to health, but it is not at all clear that this justification is based on factual evidence, or that such an assumption facilitates progressive research.

The emphasis on disease, and the idea of protective factors, suggest that stress, like a virus is a relatively straightforward threat to health. As can be observed in attempts to find medical 'breakthroughs', a great deal of effort is expended in the attempt to prove that one factor, in this case stress, is a cause of disease to the exclusion of all others factors such as nutrition or health behaviours.

Another implicit theory which emerges from a discussion of variables is based on an engineering analogy. This has a strong influence on the way in which variables are conceptualized and measured. They are measured as either stress or strain variables, objectively, and independently. The engineering analogy also has strong effects on the design of studies, and the inclusion or exclusion of particular variables.

An impression of what stress is from the measurement of variables is that stress is what stress does. Or rather, stress is what stress is supposed to do, which is cause disease. The implied relationship between stress and disease, which is at times almost synonymous, further encourages the view that stress is a 'bad' thing.

Four theories emerge when the question 'where is stress?' is considered. The first, which uses external, stimulus-based answers pays little attention to the nature of the response, while the second, which adopts internal response-based answers likewise gives little attention to the nature of the stimulus. Both these implicit theories are powerful in that they place stress in a fixed category of 'out there' in the environment or 'in here' within the person. A third theory, of stress as an interaction, can be found when intervening or moderating variables are used. Such a theory implies that stress is a stimulus and a response, but between the stimulus and response other processes are operating, or that stress is an interaction between the environment and the person. This theory accepts both stimulus and response based approaches, but adds a new class of intervening or moderating variable. Lastly, transactional theory is, in contrast, critical of the ideas of stimulus, response, and interaction. This theory appears in debates concerning the methodological confounding of variables. Stimulus, response, and interactional theories assume that variables can be measured independently on these levels, whereas transactional theory views such confounding as inevitable.

Few theories emerge from attempts to answer the question 'when does stress occur?'. From the measurement of variables it appears that stress can occur as a discrete stimulus or as a chronic situation, and the processes involved can operate over seconds or years. There may be some implicit theories used by researchers who adopt particular measures and particular time frames for measurement, but a strong impression is that researchers do not consider time to be of primary importance. Where a time frame, or a distinction between a stimulus and a situation is made, this does not appear to be the result of any implicit theory, but as a consequence of the measures used.

Who experiences stress? Two implicit theories, nomothetic and idiographic, suggest that everyone experiences stress, and/but that some people do more than others. In some ways these theories are complementary and in others they are contradictory. Where they are complementary, stress can be seen as something which everyone experiences at some level, as something which is a part of life, as is the assumption that because people are different, some people will experience stress more than others. Where they are contradictory however, stress must either affect everyone more or less equally, or it will only be experienced amongst certain individuals with particular characteristics.

Obviously these theories, whether seen as complementary or contradictory, depend almost entirely for their existence on the criteria which determine the presence or absence of stress.

These implicit theories have in a number of places become quite explicit, particularly where the methodology depends on theoretical support. However, those that remain more implicit often have a stronger and more pervasive influence on stress research, because they are less consciously used. Implicit theory based on the engineering analogy, for example, can be found lurking in almost all methodology in stress research. A number of these theories are by no means unique to stress research. Many of them originate from other disciplines, such as the engineering analogy, or the informal medical model of disease. Some theories, such as those based on stimulus/response, interaction/transaction, nomothetic/idiographic are to be found also in traditional psychological and sociological debate. And yet others seem to arise from quite general ideas which cannot be located in any particular discipline, such as the functional description of stress as 'stress is what stress does'.

The question remains of why there are so few implicit theories which are unique to stress research. Of course implicit theories are often, by their nature, quite non-specific theories. They act as general mechanistic metaphors to 'explain' a whole host of phenomena. But another reason may be that the predominant idea of stress is too broad and diffuse to support or generate any specific implicit theories. These implicit theories have played a central role in the development of methodology and empirical practice in stress research. What emerges from this examination of the components of stress research is not necessarily a clearer picture of stress as a phenomenon. What emerges instead are theories which help to direct and focus the picture on often quite different phenomena, looked at for different reasons, and with different foci. There is no clear picture of stress as a phenomenon, but a large collection of pictures. While the general heading is stress research, an observant viewer or critic may find it difficult to observe a coherent theme running through these pictures.

3.2 Explicit theories of stress

So far no attempt has been made to discuss explicit theories of stress. Explicit theories are defined here as general theories of stress which attempt to explain the relationships between a large number of the variables in stress research, and/or describe or provide an explanatory framework for the phenomena of stress. The term 'model' will be used in the following discussion to describe a representation of a phenomenon which is less general and/or less explanatory than a theory or a theoretical framework.

There are many explicit theories, discussed above, which attempt to relate together two or three variables. For example in Karasek's theory (1979), the nature of the relationship between three variables (job demands, job decision latitude, and mental strain) is described. Another example can be found in the debate on the direct versus the buffering effects of social support on health discussed in Chapter Two in which the theories describe the relationship between two or three variables. Other types of specific theories include those which attempt to account for the effects a stressor may have on dysfunctioning over time. Singer and Davidson (1986) for example make a distinction between pathogen or physiological reaction model and an interactive transactional model of the effects of stressors on dysfunctioning. In addition to initial impact models, in which the effects of the stress may lessen over time, Frese and Zapf (1988) discuss five variants of the exposure time model, where dysfunctioning may or may not continue after exposure to the stressor has ceased.

Such theories are not general theories of stress, but theories which explain a relatively small subset of components or variables embedded in a much broader context. It could be argued that these small theories can be combined in an additive way to produce general theories of stress. This does not appear to have happened, and probably could not happen in stress research. A physical science may use agreed research technologies and instruments to examine small parts of a large, but quantifiable and measurable phenomenon in the hope of combining small specific theories and findings into general theories and explanations. This analogy does not apply to stress research as there is little agreement on technologies or the parameters of the phenomenon under study.

Despite general agreement that, in principle, stress is a dynamic and complex adaptive process and that an "increasing consensus has been developing among investigators about the factors that contribute to stress" (Appley & Trumbull, 1986, p. 309), relatively little effort has, in practice, been directed towards specifying or examining this process, or developing theories which describe these dynamic, adaptive processes and the factors involved. This effort is relatively low compared to, say, the effort expended in the attempt to demonstrate that a link between stress and health may exist. No explicit theories of stress exist which fit the definition of a general theory described above. Both the context of and approaches to the development of theory have constrained the efforts made towards reaching such a goal. The remainder of this section will go on to discuss these topics, and to describe in more detail the requirements for a general theory of stress.

3.2.1 The context of theoretical development

Theoretical development has taken place in the context of quite widespread, though often inconclusive and limited debate about definitions of stress (as discussed in previous chapters), and conceptualizations of stress. Given the scope required by a theory of stress it is not surprising that these debates have been inconclusive. This limited approach is evidenced by their brief appearance in the introductions and discussions of research reports as a justification of current research or the need for 'further' research. In addition to these debates, some limited efforts have been made to discuss issues of theory as a more substantive topic and in a more critical manner. Such efforts have been apparent for some time, as the following examples published up to and including 1978 show.

In 1961 Dohrenwend attempted to provide a framework for causal inquiry in order to give some "theoretical perspective" (p. 295) to the assessment of stress. In 1967 the central aim of a book edited by Appley & Trumbull was to discuss theoretical issues in research. McGrath (1970) edited a book whose purpose was "to explore a number of the conceptual, substantive, and methodological issues which are crucial to stress research...and which are therefore preconditions to advancing our knowledge..." (p. 4). Indeed from a total of seventeen chapters in this volume, ten were devoted almost exclusively to theory. Writing in 1973, Hinkle comments that:

> The questions that have been raised about "stress" have to do with whether or not the concept provides an adequate description of the data that are now available to us, and whether or not it is any longer a useful intellectual tool, even when it is used in a descriptive sense (p. 32).

Cassel (1974) writes that the methodological problems encountered in attempting to determine the relationships and processes between social factors and disease are caused by "inadequacies in our theoretical or conceptual framework" (p. 471). And further, observing the "inevitable" (p. 108) use of the idea of stress in any discussion of role of the social environment in disease Cassel (1976) states: "I think the simple-minded invocation of the word stress in such thinking has done as much to retard research in this area as did the concept of miasmas at the time of the discovery of micro-organisms" (p. 108). Rabkin and Struening (1976) in a review of life events, stress and illness conclude that "although conceptual and theoretical orientations should play an important role in the design and execution of empirical studies, this does not appear to be the case..." (p. 1091). Kasl (1978) referring to the trivialization of stress research by inadequate methodology comments thus: "Frankly, if our conceptualization dictates trivial methodology, let us change the conceptualization..." (p. 36).

Many other examples of substantive and critical discussion of theory in stress research, published both before 1978, and up to the present day could be given. In general, these discussions and debates have changed little over the years, and, comparing the issues in stress research in the mid-1960s with stress research in the mid 1980s, Appley & Trumbull (1986a) comment that "some of the same fundamental problems remain today" (p. 3).

This is perhaps an unusual context for the development of theory. Few have doubted the need for more or indeed simply some theory, but a number of the above commentators seem to question the need for a general theory of stress at all.

3.2.2 The development of explicit theories of stress

As discussed in Chapter One, early theories of stress were dominated by Selye's (e.g. 1956) notion of stress as a nonspecific response of the body to any demand. Although this theory was largely physiological it was to have profound influence on psychological theories. "Following Selye's 1955 invited address to the American Psychological Association, both his term and straightforward model were applied widely, though largely uncritically, by clinical and experimental psychologists alike" (Appley & Trumbull, 1986a, p. 5). They go on to suggest that once this model was adopted, a clear role for psychologists was to determine, using psychological techniques, who was affected by stress, and also to quantify stress. The use of individual difference measures, life events inventories and the inclusion of coping and cognitive processes expanded the concept of stress to encompass a huge range of psychological phenomena.

Descriptive models

The word and the concept of stress became fashionable. Some researchers who were working with related concepts simply renamed the phenomena they were studying as 'stress' and continued to do exactly the same research (Cofer & Appley, 1964). Theories of stress had to develop in an ever broadening, and rapidly expanding context. It is perhaps therefore unsurprising that many of the emerging 'theories', sometimes described by their proponents as models, were narrow and inevitably simplistic.

> Over the years then there has been a steady output of such limited aspects of the total picture with block diagrams, flow diagrams, systems analyses, and verbal rationalizations for utilization of the stress concept. Most block diagrams included various forms of "black boxes" in which vital and intricate functions were labelled cognition or coping at a point where something was supposed to occur. (Trumbull & Appley, 1986, p. 22)

A very large number of such flow diagrams appeared, containing 'black boxes', joined with lines and arrows to imply causal direction (e.g. Cooper & Marshall, 1978; French et al, 1982; Kagan, 1981). Such a response, made in an attempt to manage the perception of a complex and even overwhelming array of phenomena, is understandable. However such attempts to "structure or model the research entity of stress...may be beguiling simplifications and not explanations at all" (Appley & Trumbull, 1986a).

A brief examination of more recent models (e.g. Fletcher, 1988) reveals that these models are often little more than lists of variables placed in some assumed causal order. As such they are not really theories of stress, but descriptive frameworks in which stress, moderating and strain variables are placed. In general terms, stress is seen as a stimulus or as arising from a 'source' (e.g. life events or job demands), strain as the response (e.g. symptoms), and the presence, absence or degree of strain is moderated by other variables (e.g. coping, Type-A behaviour).

Person-environment fit and transactional theory

Some important exceptions to these perhaps atheoretical approaches to the development of theory are those which attempt to explain why some classes of variable may be causally connected. The most well known theoretically-based model is perhaps person-environment fit (P-E fit) (e.g. Caplan et al, 1975; French et al, 1974, 1981, 1882; Harrison, 1978).

Many of the variables measured in P-E fit research are based on broadly similar constructs, such as workload, to those used in other studies. However, P-E fit research makes a distinction between the objective and subjective person, and objective and subjective environment, while conceptualizing "both the person and his or her environment along the same dimensions" (French et al, 1981). When the person and the environment are measured along the same dimensions it is then possible to determine the degree of objective and subjective fit between the person and their environment. Higher levels of mismatch between the subjective person and their subjective environment have been found to be associated with higher levels of psychological strain (operationally defined by negative affective states).

Such findings are not particularly ground-breaking, even if, as French et al (1981) point out, measures of P-E fit "can account for additional variance in strain which cannot be predicted by linear relationships with the E or P components, either singly or in additive combination" (p. 43). Research conducted using P-E fit has been mainly cross-sectional (e.g. Caplan et al, 1975) and hence the impression is easily formed that it is a static, traditional antecedent-outcome theory. This empirical and methodological limitation belies the fact that the theoretical foundations of P-E fit are actually relatively transactional and process orientated: "We conceive of the person and his environment as an open cybernetic system...with feedback mechanisms" (French et al, 1981, p. 42).

Other writers and theorists who have adopted a transactional approach include Cox (1978), Cummings & Cooper (1979), Lazarus (1966), McGrath (1970a), Pearlin et al (1981), Scott & Howard (1970). As the previous discussion has indicated (particularly in sections 2.3.1. and 3.1.3.), the relationship between the person and the environment can be described in fairly straightforward stimulus-response terms or in more complex interactional or transactional terms.

Although the specific details differ, each of these transactional theories describes a general process of stress which has a number of characteristics.

First, each emphasises the importance of the time dimension (e.g. anticipation, duration, short-term versus long-term effects) in this process. Second, most suggest some form of homeostatic mechanisms which operate to maintain dynamic steady states within different but interrelated systems (usually described as physiological, psychological and social systems). Third, feedback is used to compare current states with the ideal or preferred state in order to guide adaptive or corrective actions. Fourth, these theories suggest that it is deviations outside the usual boundaries of these dynamic steady states which may have implications for health.

Transactional theories do adopt the engineering analogy to some extent. Stress is conceptualized as a force, but in contrast to the engineering analogy such forces can be within or between the person and their environment and are seen to arise from some form of discrepancy between a current state and some other state, rather than as a force per se. Strain is used rather differently in most transactional models as different systems (which never experience zero load) such as the physiological, the social, and the psychological interact to produce different types and combinations of states which may have short-term and or long-term implications for health.

Theory and practice

Two general approaches to the development of theory can then be distinguished. One involves the use of flow diagrams containing black boxes in which processes are assumed to be taking place. These models usually amount to little more than descriptive frameworks in which to place variables, and the known or assumed relationships between them. The second type of theoretical development has used various elements of systems theory and cybernetics within a theoretical approach which has been described as transactional. Neither of these approaches appears to have had much influence on the practice of stress research. Black box or flow diagram frameworks, because of their atheoretical nature, are usually only used in a descriptive sense, and have therefore had no influence over how stress research is conducted. Transactional theories on the other hand, while offering more theoretically, have been presented at too abstract a level to be useful to empirical practice. These models have been described and used at a level far removed from the practice of stress research, as theoretical stances or perspectives, rather than theory designed to explain or understand findings, or theory designed to generate testable hypotheses.

McGrath (1970a) in describing his own version of a transactional theory of stress describes much of it not as theory designed to answer the question 'what is stress?', but rather a set of propositions which provide a framework for answering the question 'what is stress research?'. This distinction is important as it could be argued that most models of stress (and to some extent theories of stress) can be more accurately described as theories of stress research. The intention in such theorising is to provide a paradigm within which stress research can operate, though as discussed above, these paradigms often seem too abstract to be readily converted into research programmes.

The lack of correspondence between theory and practice is partly due to the abstract nature of some theory. But it is also the result of undertaking research without due regard for theory. Some of the reasons for this, such as the adoption of medical research rationales, have been discussed above. However, other reasons for this lack of regard can be found when one considers the implications for the predominant and more traditional style of stress research if theoretical paradigms are used to guide research.

McGrath (1970a) provides a typical example of a theoretical approach which is difficult to adopt or operationalize. In his statement of a frame of references for stress research he makes the point, which others too have made, that stress is a process and not simply a stimulus followed by a response. "The stress problem involves at least four classes of events, or panels of factors, or stages" (p. 15). Expressed briefly, this process involves the following stages: a load, input or demand; the reception or appraisal of that load as a subjective demand; the responses to the subjective demand; and the consequences of the response. McGrath (1970a) goes on to suggest that:

> In principle, every programmatic stress research effort should be concerned with this whole series of events and their specific linkages, although specific stress research studies may well wish to limit concern to portions of this total span. (p. 16)

It is clear that most stress research is not programmatic in the sense described above as it fails to study the whole series of events in the stress process. Some of the most important reasons for this can be found in the abstract nature of the proposed conceptual framework: The description of these stages or series of events provided by McGrath gives no methodological or empirical guidance for assessing or researching these stages, though there may be broad support for the theoretical perspective. If, however, stress researchers were to attempt to adopt this conceptual framework it would not only undermine much previous research but would also involve the abandonment of many current methodologies and empirical practices and the development of quite different research strategies. The predominant transactional/systems theories of stress, partly as a result of their abstract presentation, and partly because of costs involved for current research of adopting more sophisticated theories, have not been integrated with the practice of stress research.

The lack of correspondence between theory and practice has become a mutual hindrance, slowing the development and application of theory and methodology. There is a growing recognition that the continued use of some kinds of methodology, and the repetition of basic findings, are no longer acceptable if stress research is to develop. For example, an editorial in the Journal of Applied Psychology (Schmitt, 1989) stated that "additional research on stress, job satisfaction, and job characteristics in which all variables are self-report measures are no longer acceptable, but we might be willing to accept a paper in some new problem area that included only self-report measures" (p. 844).

It is worth restating here that a number of the components of stress, or variables in stress research such as coping, control and well-being (discussed in Chapter Two) evidence a similar gulf between theory and practice or methodology. For these components too it has recently been suggested that a systematic and active approach must be taken to the measurement of these variables. In the case of coping for example, Carver et al (1989) adopt a quite explicit theoretical strategy to the development of their measure of coping.

The gap between theory and practice has arisen then partly as a result of existing theories, and partly as a result of well-established practices in stress research, which seem to preclude the active incorporation of theory. Such difficulties have recently begun to be addressed by active criticism of traditional stress research and by encouraging the development of measures which are firmly rooted in theory.

3.2.3 The requirements of a theory of stress

Under the sub-heading "requirements of a satisfactory model of stress" (p. 269) Scott and Howard (1970) outline six characteristics of "an acceptable stress model", where acceptable means "capable of integrating existing knowledge into a single, unified framework" (p. 269). While this general aim is partly shared here, there is an acknowledgement that integration may not be possible: That phenomena may be sufficiently diverse to preclude integration, and that it is not necessarily beneficial to attempt to integrate existing knowledge. It is difficult therefore to specify the characteristics of a satisfactory theoretical framework, which, as stated earlier in this chapter is considered to be broader and more explanatory than a model. It is perhaps the approach to theory rather than the theories themselves which require examination. It is apparent from much of the above discussion that the two general approaches to theory are inadequate, though the question of what kinds of theories would be adequate needs to be answered.

The first part of this answer focuses on what it is that theories of stress are attempting to explain, and the second addresses the level of articulation of theory and the extent to which such theory can facilitate the development of methodology. Each of these will be discussed in turn.

What are theories of stress attempting to explain?

It is difficult to clearly describe existing theories of stress, and equally difficult to summarise what such theories are attempting to explain. As discussed above, explanatory theories are often presented in quite an abstract way. In general terms though, most theories of stress attempt to explain, or to describe the relationships between psychological phenomena and health.

More specifically, such theories have tended to be quite conservative in the limits which are placed on these two areas: Psychological phenomena are often restricted to relatively traumatic environmental events or situations, and health is often defined in terms of the development of illness over long periods. Because of such limitations, it could be argued that many theories of stress are attempting to account for the observed, though often weak, relationships between the experience of dramatic change, or reported mismatch between the person and their environment, and reports of illness. Such accounts concentrate on the specific qualities, quantities and nature of the change or the relationship between the person and the environment, leaving illness on a fairly undifferentiated, non-specific level of description. It has been suggested that stress resistance or health should be explicitly studied rather than only illness (Antonovsky, 1987; Holahan & Moos, 1990).

Current theories of stress are limited in their scope, which suggests that one of the main requirements for more acceptable theories of stress is that they attempt to explain a broader range of relationships between a more widely conceptualized environmental change or person-environment mismatch and health.

Chaotic systems and stress phenomena

Although a detailed discussion of the nature of chaotic systems is beyond the scope of this thesis, they are highly relevant to its subject matter, as the behaviour of some if not all of the systems involved in stress phenomena is likely to be chaotic. One of the central features of chaotic systems (see Gleick, 1988) is that they are nonlinear, expressing relationships that are not proportional, and which therefore do not settle to a steady state nor into a repeating pattern of behaviour. A system which behaves according to linear relationships on the other hand would be entirely predictable given initial starting conditions, would fall into a steady pattern of behaviour, and the effects of any input would be predictable. Examples of chaotic nonlinear systems include waterfalls, the fluctuation of animal populations and commodity prices, heart rate, and convection.

Of particular importance here are the implications of chaos for the study of systems which behave in a nonlinear way. If, for example, the states of these systems cannot generally be predicted, if very small changes can have very large effects, and the system moves irregularly through periods of predictability and then unpredictability, the usual ways in which systems are studied will not reveal these more subtle patterns of causality.

The weather is another example of a chaotic system, and provides an analogy which demonstrates the limited way in which the study and conceptualization of stress phenomena has been approached. In this analogy, health can be considered to be equivalent to weather outcomes. An extremely limited theory of the weather would only attempt to explain the occurrence of heavy rain in relationship to a few environmental features over particular time frames. A more sophisticated theory of the weather would firstly account for a much greater range of outcomes (e.g. drizzle, snow, sunshine, etc) and incorporate a great many more predictors (e.g. climate, seasons, detailed records of other weather conditions, small local variations in environmental features, the use of many different time spans and frames, etc).

A more sophisticated theory of stress would have to incorporate a much wider range of adaptational outcomes, a wider range of time frames, and a greater number of environmental changes and person-environment relationships. Such a theory would also be able to accommodate and integrate related concepts such as coping and control. If stress phenomena can be incorporated within the notion of a chaotic system, then such a system must also be considered to be ultimately unstable, though periods of stability will occur. An approach which embraces the notion of chaos and rejects simple determinism, enforced clarity, and often trivial levels of predictability, seems to offer some possibility of understanding stress phenomena.

Many current theories of stress are inadequate because they explain too little through self-imposed limits. The attempt to provide explanations of what are potentially extremely complicated relationships (e.g. between environmental characteristics and health) becomes trivialized by simplifying the conceptualizations of the phenomena under examination, and limiting the range of outcomes which are studied. Accepting that the systems involved may be chaotic does not mean that predictions can no longer be made, but they will be different kinds of predictions, that can only be made under specific circumstances, and will not necessarily apply across situations, time periods, or individuals. Different methodologies will be required to detect the rhythmical and irregular functioning of these systems.

<u>How can theory facilitate the development of methodology?</u>

From the discussion of theory and practice in stress research above, it is clear that many existing theories of stress do not facilitate the development of methodology. Some theories may be untestable or not facilitate methodology because they are speculating, say, about phenomena which it is impossible to measure or assess. Theories may also not facilitate the development of methodology if the intention of the theory is for some purpose other than a practical one: For example a theory may attempt to integrate other theories, or to be used as a stimulus for others.

Existing theories of stress do not fall into either of these categories. They have failed to facilitate theory because they have remained on too abstract a level to be operationalised. They are often stated as quite general principles (e.g. person-environment fit) rather than on a level which specifies details. However, theories can facilitate the development of methodology if these lower level details are specified. The second requirement for a theory of stress is that it should, or at least parts of it should, be articulated at a level, which quite clearly suggests methodology.

These two requirements, first, that theory is broad and second, that it is detailed, are not intended to be general requirements for theory in all areas of research. Other areas may have quite different problems which require different solutions. These requirements are derived from observed shortcomings in the existing theory and methodological and empirical practice in stress research.

3.2.4 Conclusion

There are only a very few explicit and general theories of stress. Those which do exist are either descriptive, or are presented at too abstract a level to be useful in the practice of research. In addition the development of theory has been slow, due mainly to a gulf between theory and practice and methodology.

It could perhaps be argued that a lack of explicit theory, or the slow development of theory are not particularly important in an area which is in a number of ways an applied research area. Such an argument could be easily supported if stress was a new area of research, where the priority was to undertake exploratory investigations. However, stress research is not particularly new, and there are an increasing number of indications that stress research which is atheoretical, or where the measures used are not theoretically supportable, is becoming less acceptable, even within the scientific community.

While a consensus on the nature of stress as essentially a transactional process is apparent these theories remain on an abstract, if not an almost campaigning level. It is essential that theory is developed, refined, and made more applicable to the practice of research and methodology. The remainder of this chapter will attempt to do this.

3.3 A rational approach to theory building in stress research

This section will develop and refine theory by taking a particular kind of approach, a rational approach, to theory building. The next section (3.4) will discuss how this theory can be translated into methodology. The term rational as used here has a technical meaning, and it is not used to suggest that other approaches to theory building in stress research are irrational:

> ...empirical psychology is a psychology based on observation and experiment as contrasted with rational psychology based on deduction from general philosophical principles... (Drever, p. 83. Penguin Dictionary of Psychology)

A rational approach then is one which bases its statements not on observations or data, but on general principles, or on other theories and theoretical systems. While the approach taken in this thesis is, on the whole, empirical, the approach taken to theory building is not. As stated a number of times, in this and the previous chapter, the empirical approach has not been particularly successful in increasing our understanding of the nature of stress.

Increasing interest in the relationships between theory building and research progress, and between rational and empirical approaches is evident in recent debates concerning theory in general psychology (Greenberg et al, 1988; Greenwald et al, 1986; Greenwald and Pratkanis, 1988; Mackay, 1988; Moser et al, 1988) and theory in occupational and organizational psychology (Bacharach, 1989; Van de Ven, 1989; Weick, 1989). It is clear from these debates that other areas of psychological research are also perceived to be handicapped by inadequate theories, and indeed that what appears to be research progress can hinder the development of theory.

In stress research, a cause and a consequence of the problems of empirical approaches to theory building, is the positivist approach to scientific research and knowledge, reflected in attempts to impose simple cause-effect models on stress phenomena, and to remove confounding between variables.

> Thus, some of the confounding...reflects the fusion of variables in nature rather than being merely the measurement errors of researchers. If we try to delete the overlap in variables of genuine importance we will be distorting nature to fit a simpler, mythical metatheory of separable antecedent and consequent variables. We urge researchers to be very wary of throwing out the baby with the bath water in their efforts to objectify stress as an event in the environment. The positivist position has, over the past 15 years, repeatedly failed to demonstrate its usefulness in stress and coping research. (Lazarus et al, 1985, p. 778)

Attempting to contribute to understanding by using methods, measures, and making assumptions which are not theoretically grounded is unlikely to be effective.

This section will demonstrate that a number of the previous problems encountered in developing theories of stress can be approached by taking a broader, more eclectic approach to stress phenomena. Such an approach is facilitated by starting from a firm position of doubt.

What we do not know and what we do know

Taking a rational approach requires that the usual answers given to the fundamental question 'what is stress?' can no longer be accepted: Whether that answer is given in terms of responses (e.g. strain), or as stimuli (e.g. a life event), or as an interaction between a stimulus and a response. The problem with the first two types of answer is that they do not take account of the fact that the 'stimulus' does not always produce the 'response', and the definition of stress therefore becomes circular. In addition, there are phenomena which could be considered both to be stimuli and responses, and yet other phenomena (such as processes) which cannot be described in stimulus-response terms. In the third type of answer, where a more interactional model is adopted, the assumption remains that stress is somehow an interaction between a stimulus and a response which enters into an relatively unknown system, often depicted as a black box, which then responds. Interactional models at least acknowledge that such systems exist, but on the whole do little to explore them. (As stated above, transactional theories are usually expressed at too abstract a level to be practically useful, but they do in part reflect the chaotic nature of the various systems which theories of stress attempt to describe and predict.)

The most important consequence of not accepting these usual answers regarding the meaning of stress is that our claims to knowledge are considerably weakened. The assumed general relationships, for example between stress and illness, no longer make sense without the usual theoretical frameworks. We cannot know, and it does not make sense to suggest that, stress has relationships with anything else if we reject its status as a stimulus, a response, or an interaction. While we do not know about relationships or processes, we do know something about states, and movement within those states. For example, we know that people report varying levels of symptoms, and that the level of these symptoms is likely to fluctuate within the person. We know that transactions between people and their environments possess psychologically salient (though weakly conceptualized and operationalised) characteristics such as social support or control. We know that transitions to, and movements within various states depend partly on the state concerned, the level of that state, and more crucially on the length of time within which we consider the transition to operate.

The starting point of this approach requires that only this small number of assumptions regarding our current state of knowledge are made. From this position of confident ignorance, some general principles can be applied to these assumptions in order to develop a theoretical framework.

3.3.1 The linking concept of adaptation

The concept of adaptation can be a useful way of approaching and encompassing stress phenomena (see Chapter Two). This concept has been used in relation to a wide range of stress phenomena (Hartmann, 1958; Hinkle & Wolff, 1957; Moos, 1976; Selye, 1956; Serban, 1976; Vaillant, 1977; White, 1974) and is useful precisely because of its general applicability, and its firm emphasis on change, response to change, continuity, and the regulation of systems. Trumbull & Appley (1986) remind us that we "must...be aware of the dynamic nature of such systems, their development, the underlying rhythms, and the ebb and flow of adjustment in their normal variations, from circadian to life cycles" (p. 22).

As adaptation refers to adaptation of systems; inputs, rather than stimuli, enter an active, on-going system which produces many types of outputs. Some of these outputs may be quite directly related to the input, others may not be. An input into an active system sets up a potential for adaptive activity, rather than necessarily producing an output. Any stress phenomena can be considered as inputs or outputs, depending on the system, and the point at which it is examined.

Adaptation and levels of analysis

In general terms, the more distal the assumed relationships between inputs and outputs, the greater will be the difficulty encountered when attempting to understand the processes and systems involved in the production of inputs and outputs.

If we want to examine the dynamics of adaptation and stress phenomena, it is necessary to consider states on a level which reveal the processes involved. For example, it is impossible to understand the processes involved in cooking if one only looks at ingredients and then the finished product. The level of analysis usually adopted in examining stress phenomena is exactly at this gross level.

The level of analysis most suitable for the examination of these states will be determined partly by the nature of the state, but should in general be as fine-grained and detailed as it can be. It is possible, or more likely probable, that different explanations are required for different levels of analysis. That is, there is not simply a difference in quantity, but a difference in kind between the processes and states which occur on a detailed and specific level and those which occur on more gross levels. In a similar way, the same laws of mechanics cannot account for the behaviour of visible objects (chairs, tables), and those objects which are much smaller, such as sub-atomic particles or much larger, such as universes.

Figure 3.1 below gives some examples of various levels of analysis in terms of both time and intensity. Other distinctions, such as psychological and physiological sub-systems, or inputs and outputs, on which to base levels of analysis could equally well be used.

Figure 3.1. Examples of various levels of analysis, and stress phenomena which may exist on these levels.

	INTENSITY	
	Low	High
DURATION		
Short-term (mins/hrs)	Waiting in traffic jam when late.	Reviving dying patient.
Medium-term (days/weeks)	Learning new work procedure.	Exam revision.
Long-term (months/years)	Unemployment.	Cluster of life events

Adaptation taking place on one level may have effects on the other levels, and long-term stress phenomena may express themselves in terms of short-term phenomena. Stress research has tended to focus on long-term levels of analysis which precludes examination of adaptive processes. For example, unemployed people may report higher levels of depression, but analysis on a gross, long-term level would reveal nothing about why or how this may occur.

Figure 3.2 shows how these examples of levels of analysis would be described in terms of associated health effects.

Figure 3.2. Examples of various levels of analysis in terms of possible/assumed effects on health.

	INTENSITY	
	Low	High
DURATION		
Short-term (mins/hrs)	Irritation. Anxiety.	Strong physical activation.
Medium-term (days/weeks)	Tiredness. Headaches.	Insomnia. Appetite loss.
Long-term (months/years)	Depression.	Coronary Heart Disease.

Here too, states described on one level may influence others, though there is little evidence to support this. The intuitive appeal of the idea that people who regularly experience strong physical activation throughout their lives develop heart disease cannot be supported by empirical evidence. However, it would appear that in order to understand whether the stress phenomena described in figure 3.1 can have any effects on these health outcomes, again it is the detailed and specific, short-term level of analysis which is required. Many other systems, on many more levels of analysis could be described. However, the main point to emphasise is that adaptation is a useful concept which encompasses most if not all stress phenomena.

Adaptation is also useful because it emphasises that time, or time frame, or time scale, is probably the most important dimension to consider in the interpretation of stress phenomena. An adaptive process which takes place over several decades may be unconnected with, and function quite differently from, adaptive processes which take place over days, even where the processes appear to be occurring in the same system.

Moving from states and variations in state, and then linking these states together within a framework of adaptation and regulation described in this section, the next stage is to describe a mechanism or mechanisms by which systems are regulated.

3.3.2 Control theories

The cybernetics movement, heavily influenced by Weiner (1948) proposed that the self-regulation of systems operates through feedback mechanisms in similar ways in both physical and biological systems. The same theoretical principles, emphasising homeostasis are found in the work of Bernard (see Olmsted, 1939) and Cannon (1935, 1939), discussed in Chapter One. The idea of feedback or control mechanisms has been used to describe the behaviour of a wide range of systems (e.g. Emery, 1969; Miller, 1978; Sluckin, 1960). Indeed it is so firmly established in psychological thought, through the work of Miller et al (1960) and their description of the test, operate, test, and exit (TOTE) control loop, and later work by Carver & Scheier (1981) that it is difficult to imagine other types of mechanisms apart from those based on control/cybernetic models of system functioning.

The predominance of this way of thinking about systems, has disadvantages in that critical debate is difficult to achieve in the absence of alternatives. On the other hand, this predominance also provides a way of linking different aspects of stress phenomena, and facilitates generalisation.

The essence of adaptive systems is that they respond to internal or external changes by returning to or moving towards some dynamic equilibrium. Most, if not all, of the more transactional theories of stress phenomena use some part of control theory to define or describe stress. A typical description is given in the following quote:

> Each of the numerous variables in an organism has a specific range of stability...A stress is any force displacing a variable beyond its range of stability. (Cummings & Cooper, 1979, p. 397)

Elements of control theories are usually incorporated into theories of stress phenomena at this somewhat unsatisfactory general level, so leaving these theories firmly rooted in the tradition of those based on the engineering analogy. Stress, rather then simply being a force, is defined as a displacement beyond particular boundaries. A further difficulty with the vague use of control theories is that, like the engineering analogy, they insinuate that explanation is present within a theory, and give the explanation an air of scientific validity.

In addition, as control theories originated in the biological sciences, a link between psychological and physiological systems and phenomena is suggested which may or may not be present. As discussed in Chapter One, Selye's notion of the General Adaptation Syndrome (e.g. Selye, 1956), despite being a physiological theory, was readily adopted by psychologists. In the continuing enthusiasm to demonstrate a link between psychological phenomena and health, theories which have physiological/biological 'hard' science origins, remain popular.

Despite these potential shortcomings, control theories are useful in that they suggest dynamic phenomena, and have a generality which means that quite different system types (e.g. psychological, social, physiological) with varying levels of subsystems and complexity can be viewed individually and together as possessing the same operating mechanisms.

Feedback loops

The fundamental mechanism in control theory is a negative feedback loop. In such a feedback loop, input is compared with a reference criterion. If this comparison process detects a discrepancy, some form of response is made to reduce this discrepancy. The organisation of these loops can be considered to be hierarchical (Hyland, 1988; Powers, 1973; Scheier & Carver, 1988). Discrepancies at higher levels will be removed by making active reference criteria at lower levels. For example, through negative feedback the level of social contact may be detected as lower than the reference criterion. Reference criteria at lower levels, such as the frequency with which one goes out, or the extent to which one engages in casual conversation may be activated, which in turn activate reference criteria in control loops further down the hierarchy. The nature of this hierarchy, and how and why discrepancies arise will be discussed in the following section. Here, the problem of how different types of systems, regulated by negative feedback loops will be discussed.

The roots of this problem are the same as those problems encountered whenever discussion between psychological and physiological phenomena takes place. However, as discussed in Chapter One, physiological and psychological notions of adaptive processes involved in stress phenomena have become confused. Assumptions are frequently made that these systems are connected, though the causal links or specific pathways of influences are rarely, if ever, specified. While the hierarchical organisation of control loops is plausible, it is difficult to envisage the nature of the organisation between a physiological and a psychological system. While, say, the physiological correlates of the psychological state of anxiety can be specified, this does not enable us to understand how physiological arousal *as a system*, and psychological affect *as a system*, are related.

Each system may contain control loops, organised hierarchically, and each system as a whole may be regulated in a homeostatic manner through these control loops. One system may affect the other. However, the question remains of how these two systems are organizationally related.

Loose coupling

One possible answer to this question can be found in the concept of loose coupling (Glassman, 1973). This concept was developed in order to permit a general systems theory of living organisms to be less mechanistic and allow the possibility of indeterminism. Like chaotic systems, living organisms vary along a dimension of stability - instability at different points in time. A rigid coupling between systems within an organism would not permit such variability. In addition, rigid coupling would not explain the persistence of certain responses despite variations in inputs.

> The degree of coupling, or interaction, between two systems depends on the activity of the variables which they share. To the extent that two systems either have few variables in common or if the common variables are weak compared to other variables which influence the system, they are independent of each other. It is convenient to speak of such a situation as one of loose coupling and also to note that insofar as one system, A, is independent of another, B, we may speak of the persistence of the behaviour of A in the face of the behaviour of B. (Glassman, 1973, p. 84)

This concept is generally useful, and seems to be specifically useful to any theoretical synthesis of stress phenomena: The varying strengths and interpretability of the complicated relationships between stress phenomena, suggests that these phenomena may be produced by different systems which are actually loosely coupled.

In addition the looseness, or tightness of coupling between systems may account for the fact that a large number of stress phenomena, such as social support, are interpreted as moderating variables. Higher levels of, say, social support may reduce the tightness of coupling between affective systems, and physiological systems. Another example can be found in the relationship between workload and coronary heart disease, which is only present when levels of controllability are perceived to be low.

The concept of loose coupling between systems has also been used to describe work organisations (Orton & Weick, 1990; Weick, 1976). In this context, loose coupling has been defined as where the elements within a system are responsive, whilst maintaining individual identity (Weick, 1976). Such an approach is seen to be similarly useful in the interpretation of organizational phenomena. However, Orton & Weick (1990) suggest that the concept has moved away from its original formulation, stating that "it is essential that the concept of loose coupling remains dialectical rather than unidimensional" (Orton & Weick, 1990, p. 218). They add that:

> Research methodologies that encourage researchers to parse dialectical concepts into unidimensional variables should be avoided. The frequently pursued direct effect, X causes Y, is still the social science ideal. The numerous, more complicated forms of this relationship have been considered as disappointing approximations to this ideal...To serve the dialectical interpretation of loose coupling, researchers must continue to transform methodology to serve theory, rather than transforming theory to serve methodology. (p. 218)

Loose coupling offers a way of viewing relationships within and between stress phenomena, organizational systems, and more generally, any complex systems.

It does not directly explain phenomena, but provides an account of how systems and sub-systems, operating on the basis of feedback loops, can be organised in an indeterministic and more complex way than tightly coupled systems would allow.

The definition of and number of systems

Although it has been a suggested that all stress phenomena can be viewed in terms of adaptation within and between a number of loosely coupled systems, the term 'system' has not yet been defined. As a consequence, it is not yet possible to make an assessment of the number of systems which encompass stress phenomena. The concepts and debate involved in the development of theory about systems and their organisation, form, function and purpose are extremely complicated (e.g. see Emery, 1969; Feibleman and Friend, 1945; Sommerhoff, 1969), and span a number of disciplines including biology, physics, and engineering. A full discussion of the issues surrounding systems theory is beyond the scope of this thesis. However, certain issues, in particular the definition and number of systems involved must be discussed, though they cannot be resolved here.

Miller (1978) discusses and defines a number of types of systems, including conceptual, concrete, and abstracted. In the case of stress phenomena, systems are likely to cut across these boundaries. For example, affect is more than a concrete system, defined by Miller (1978) as a "nonrandom accumulation of matter-energy in a region in physical space-time, which is organized into interacting interrelated subsystems or components" (p. 17). While affect as a system may contain some physical/physiological elements, it also has some of the properties of an abstracted system, the units of which are "relationships abstracted or selected by an observer in the light of his interests, theoretical viewpoint or philosophical bias" (Miller, 1978, p. 19).

The term system is difficult to define, and distinctions between systems types difficult to make. One of the main reasons for such problems arises from the implication that a system contains a number of interacting elements acting together to form some sort of whole. A further difficulty involves describing the limits of a whole system. If the system is open and/or chaotic, a huge number of elements which can influence each other, and therefore the whole has almost no limits. In such a case, to define a system or make distinctions between systems becomes impossible. In addition to defining systems or system types, the existence of levels of living systems can be postulated. Miller (1978) suggests that there are seven levels of living systems: The cell, organ, organism, group, organization, society, and supranational systems. Also, he posits that each of these systems contains nineteen subsystems.

Moving from living systems in general, to people, Trumbull & Appley (1986) state that "there is a general acceptance of three parallel systems - physiological, psychological, and social - that function to maintain a person..." (p. 22). They give examples of, but do not fully describe the subsystems of each of these systems. Averill (1982) similarly distinguishes between three levels of analysis when considering systems, the biological, psychological and sociocultural. He describes three levels of organization, the system, the subsystem, and the element where "systems at different levels...may be organized in a hierarchy" (p. 5). Again, the description of these systems give no information about what the systems or subsystems are, or how they function. Like the distinctions between system types discussed above, these distinctions made between actual systems can appear to arbitrary. Even though the two examples given of the three systems influencing people (physiological and biological, psychological and psychological, social and sociocultural) reveal a degree of consensus, and have some intuitive appeal, no reasoning behind these particular distinctions is apparent.

It is clear from this discussion that control and systems theory have been used in a rather limited way, and have certainly not been applied sufficiently to be considered as theories of stress phenomena. These theories are used at the level of analogy. Like the engineering analogy discussed above, there are dangers in too readily accepting such analogies. Control and systems theory used as an analogy seems to have been readily accepted by researchers as a sophistication of the oversimplistic engineering analogy used to describe stress and strain. Sommerhoff (1969) warns that "it cannot be stressed enough that the indiscriminate application of engineering concepts to biological situations is fraught with danger. Only extreme caution and careful analysis can save us from the many possible pitfalls" (p. 199). Such a warning applies equally to the application of engineering concepts to psychological situations and phenomena.

Whilst, as Sommerhoff suggests, extreme caution has been taken here in the use and application of engineering concepts, careful analysis is somewhat limited by the scope of the work presented here. Nonetheless, it will be a crucial task in future work to make as clear as is possible how these concepts are being used, and to specify and define as fully as possible the systems and relationships within and between systems. Only by doing this will their application not prejudge the phenomena under scrutiny, as is the case with the engineering analogy.

The definition of and number of systems are complicated issues. A way through them can be found in this context by considering the function of theory in this thesis; that it should be usable, leading to and forming methodology.

> Characteristically, general systems research on living systems is concerned with confirming or disconfirming a hypothesis relevant to a given critical subsystem or to an adjustment process or other aspect of a total system. This is tested on one type of system at one level. The question may then be asked whether the same proposition has been or could be tested on other types of systems at the same level, or on systems at other levels, using comparable distinctions. If functions of variables, or similar mathematical models are applicable at more than one level, this cross-level formal identity interests the general systems scientist. Differences among levels are also interesting. Identities and disidentities must both be considered to obtain full understanding of the phenomena of life. (Miller, 1978, p. 1045)

As argued earlier, much stress research has looked for static relationships between phenomena on different levels and perhaps in different systems. Comparing life events with illness may be equivalent to searching for correlations between an individual's heart rate (Miller's organ level) and the balance of political views in the European Parliament (Miller's supranational level).

If a systems approach is to be adopted, it is important, at least initially, to examine phenomena which are in the same system, and at the same level. It is phenomena which are connected with the psychological system which will be examined in this thesis. The most useful level of analysis, as described earlier, is relatively specific and detailed, which permits the relationships and processes between phenomena to be more clearly recorded. As this analysis is limited to psychological phenomena, a number of questions arise about the ways in which control theories can be used to explain these phenomena. Most fundamental are the questions of how control loops are organised hierarchically, and how and why discrepancies arise within the psychological system.

3.3.3 Goal-directed behaviour, action theory and stress phenomena

The idea that behaviour is purposive is problematic, and has been a topic of debate within psychology for at least the last fifty years, in particular since the rise of behaviourism (Silver, 1985). Within philosophy also, the nature of goals and purpose in human behaviour have been, and continue to be fundamental to our understanding of human identity and therefore the subject of considerable discussion (Montefiore & Noble, 1989). Concepts such as will, consciousness, and intention rest uneasily with reductionist and physicalist ideas of human beings and behaviour.

The view that behaviour is goal-directed is only possible when action is taken as the basic unit of analysis, and when it is assumed that human behaviour is purposive and can be explained teleologically. This approach has strong traditions in German psychology and philosophy (Frese & Sabini, 1985) and Soviet psychology and philosophy (Kozulin, 1986; Wertsch, 1981). In particular the writings of Hegel and Marx were influential. The view of human behaviour as purposive, and in part distinct from the behaviour of other organisms is elegantly expressed, as is a view of action theory, in the following quote from Capital published by Marx in 1867:

> A spider conducts operations which resemble those of a weaver, and a bee would put many a human architect to shame by the construction of its honeycomb cells. But what distinguishes the worst architect from the best of bees is that the architect builds the cell in his mind before he constructs it in wax. At the end of every labour process, a result emerges which had already been conceived by the worker at the beginning, hence already existed ideally. Man not only effects a change of form in the materials of nature; he also realizes his own purpose in those materials. And this is a purpose he is conscious of, it determines the mode of his activity with the rigidity of a law, and he must subordinate his will to it. This subordination is no mere momentary act. Apart from the exertion of working organs, a purposeful will is

> required for the entire duration of the work. This means close attention. (Marx, 1975/1867, p. 284)

Such traditions have been drawn upon more recently, as increasing interest or perhaps a resurgence of interest in action theory and goal-directed behaviour in European and American psychology has become apparent (Frese & Sabini, 1985a; Ginsburg et al, 1985; Hacker et al, 1982; Pervin, 1989; von Cranach et al, 1982). (While there has also in recent years been an interest in action in British psychology (Clarke & Crossland, 1985; Harre et al, 1985), this has been quite limited and appears to have developed in almost complete isolation from mainland European or American work in similar areas: No cross-referencing or other communication between these two bodies of work seems to exist.) Action theory is an approach to the analysis of human behaviour, rather than a theory which can be proved or falsified. Frese and Sabini (1985) compare action theory with evolutionary theory, in that "it is hard to imagine what could convince us that natural selection is false" (p. xxiii).

The notion of hierarchies in describing the representations and structures of intentions and goals is well-established, if not almost implicit in human activity. Using Marx's example of an architect, it is apparent that the main goal is the construction of the building, and if we assume that the architect is also heavily involved in the construction (contradicting the usual division of labour), then the architect would also have a number of sub-goals, such as securing labour, materials, and planning permission. Goals below these sub-goals would involve more detailed organization of these sub-goals, such as negotiating with labour, or selecting and arranging transportation for materials. These analyses can continue downwards to examine the architect's activities on a weekly, daily, hourly, minute-by-minute, and second-by-second, and even millisecond-by-millisecond basis.

These hierarchies serve the same function for goal structures as hierarchies do in the organization of negative feedback control loops discussed above. A goal can be viewed as a social representation of a negative feedback loop: Designing and erecting a building is a large TOTE unit, where the architect will not exit from the loop until the building is complete. Within this TOTE unit will be a large number of other TOTE units guiding action on every level.

This example shows the extent to which action theory, like systems theory, can easily remain at the level of analogy. However a number of attempts have been made to move and develop concepts beyond the level of analogy. Rather than provide an exhaustive list of such efforts, some examples will be given. Goal structures can, as in the example of the architect, be both hierarchical and sequential (Volpert, 1982) which makes their organization, except in the simplest of cases difficult to imagine. Another difficulty occurs when attempts are made to specify goal levels in terms, for example, of the number of levels and how the levels are interconnected (Heckhausen & Kuhl, 1985; von Cranach et al, 1982). Further, there is the question of whether it is the case that people are always either goal- or action-oriented. Kuhl (1982) has suggested that at any particular point in time, cognitions are either action-oriented or state-oriented. In action-oriented cognitions, there is a focus on the present state, a desirable future state, the discrepancy between these and action alternatives to reduce this discrepancy. If one of these four elements is missing, cognitions are state-oriented. Another problem can be found in attempting to specify the number of types of goals there may be, independently of their place in a hierarchy. Distinctions between different types of goals such as self-defining and non-self-defining (Gollwitzer & Wicklund, 1985), chronic and temporary (Srull & Wyer, 1986) have been made, as could, presumably, many others. Such difficulties are similar to those discussed above which are encountered when systems theory is examined in greater detail.

Despite these difficulties, action theory provides at least a partial account of, and strong framework for considering, how discrepancies arise with the control loops of psychological systems. The apparent hierarchical structure of these control loops can also be more easily explained, even though, as mentioned above, the structure is undoubtedly more complicated than a hierarchy. While this work presented in this thesis is limited to psychological systems, this type of action theory analysis may not be. For example, the distinction between state-orientation and action-orientation made by Kuhl (1981, 1982) does not mean that the intentions of actions cannot be to change states, such as intense emotions, which may partly be a cause and consequence of physiological activity.

Perhaps the most important contribution towards a general framework for examining stress phenomena which can be made by action theory, is that it dismantles the traditional view that stress is an external force/stimulus. Returning again to the architect, stress phenomena over the course of the building project, such as the level of symptoms, the affect experienced, perceptions of workload and control, cannot, within this framework, be said to arise from either a property of the environment or a property of the individual. The discrepancies experienced by the architect as they carry out their activities within all the time frames discussed above will be produced by a relationship between the architect and the environment, or a relationship within the architect. In a discrepancy between a current state and a future desired state, the states referred to could be within the person, within the environment, or within a relationship between the person and the environment.

Such a perspective tends to blur distinctions between the person and the environment, particularly when the causes of discrepancies are considered. Trumbull and Appley (1986), who use the term disparity rather than discrepancy, state that "inasmuch as we are concerning ourselves with the perception of disparity, we must recognise the potential for stress arising from the needs within the individual not being met by the outer world, family, or society" (p. 39). While their use of the term stress is questionable, there is no doubt that needs and values within the individual, (many of which are actually defined by society and are therefore collective rather than individual needs and values), are a major source of discrepancy. The architect who wants to do a good job, or to get on well with work colleagues, or to appear efficient is not only expressing needs and values, but reference criteria which will produce discrepancies on a daily basis.

Discrepancies, motivation and adaptive behaviours

However such discrepancies are produced, they occur extremely frequently and may usually involve quite automatic unconscious adjustments. They are part of a cyclical, on-going process of adaptation and motivation. In some ways, to consider a single discrepancy, given its interlinkages with a complex goal structure is unrealistic and oversimplistic. Within this approach, no discrepancy or control loop can be considered in isolation. However, in order to clarify this approach, a general and limited example will be given.

The effects a discrepancy has on the person depends almost entirely on if and how the discrepancy is reduced. If the architect wants to, or is told to complete a task, X, then a discrepancy may be activated at any point in time that X is not completed. This discrepancy in itself may have no particular effects on the architect or their environment. If however, a value is placed on

X, or if the architect wants/or feels compelled to follow orders, then it is likely that a sequence of action alternatives (Kuhl, 1981) will be evaluated. The evaluation of these alternatives may then produce a range of affective responses, depending on a host of other factors, such as how difficult or easy X is perceived to be, or the consequences of failing to do X. This stage is perhaps comparable to Lazarus's (1966) notion of primary appraisal, and a part of a number of theories of emotion (see section 3.4.2 below).

In this case, if X is seen to be possible, the most obvious action alternative is to attempt to do X, which will then activate a series of discrepancies, as in order to attain goal X sub-goals a, b, and c must first be met. These may be hierarchically or sequentially organized. The above process will then take place for each of these sub-goals.

If X is seen to be not possible, in this simplified and general example, the architect will attempt to reduce the discrepancy by some other means, to question the desirability of X or of following orders, or to ignore the discrepancy. Other means of reducing the discrepancy could be to alter the goal in some way. For example, the goal could be reduced, to say half of the desired level of X, or to complete X in twice the desired/ideal time, or to only attain sub-goals a and b. Questioning the value of X or of following orders may involve appealing to higher level discrepancies (for example, if non-completion of X is discrepant with wanting to do a good job), reducing the discrepancy in one of the ways suggested immediately above (for example, accepting that completion of sub-goal b alone is sufficient to meet the reference criterion). Ignoring the discrepancy may involve switching attention away from X to another relatively unrelated discrepancy (for example the undone but desired completion of task Z, or sub-task j), or it may be possible, if one wanted, to accuse the architect of procrastination (if, for example, task

Z is arranging a long summer holiday, or sub-task j is making the 27th minor alteration of the day to the arrangement of papers on the desk).

Each of these approaches are likely to be accompanied by affect, the orientation of this affect depending largely on whether or not the architect is successful at reducing or ignoring the discrepancy. Reducing the level of X may produce feelings of incompetence or ineffectiveness, or alternatively, may facilitate activity and a sense of competence, albeit at a lower level of performance. Questioning the value of X, or of following orders by appealing to higher level discrepancies may encourage the architect to feel general dissatisfaction with the job, and with their job position. On the other hand, if a higher level discrepancy is resolved, such as an understanding that doing a good job does not mean having to complete all tasks (perhaps a similar process to insight in some forms of psychotherapy), then a longer-term sense of satisfaction may be produced. Ignoring X may produce a variety of feelings, depending on the means by which attention is refocussed.

<u>If X is attempted, but not completed as desired</u>, then the architect could reduce the discrepancy in any of the ways described above. However, if it is not completed and is viewed by the architect in a negative way, because it causes a discrepancy with the reference criteria of wanting to do a good job, then it is likely that affect reflecting this negative perception (such as anger, frustration, or depression) will be experienced by the architect. If X was particularly important, or related to a reference criterion placed towards the top of the hierarchy (for example, in order to be a decent human being the architect must attain the goal of doing a good job) such a reaction would be more marked. Processes such as cognitive dissonance (Beckmann & Irle, 1985), or rationalization may be used to reduce the discrepancy, and to promote less negative affect.

If X is attained, the state of affairs is likely to be viewed positively by the architect, and affect reflecting this (such as satisfaction, pleasure, or contentment) will be experienced by the architect. However, if X was completed to reduce or avoid the discrepancy which would have been activated should the architect refuse to follow orders (for example, the architect may want to follow orders in order to please people), then an absence of positive feedback from those giving orders may produce displeasure, dissatisfaction, or confusion/insecurity about higher level goals and beliefs.

This general and simplified example of an action theory approach to a particular and limited situation contains elements of systems theory. However, it is important that a number of distinctions are made between action theory and unsophisticated systems theory in order to avoid some of the dangers already mentioned of using biological/engineering analogies. It can sometimes appear that goal-directed mechanisms and equilibrium-directed homeostatic mechanisms are identical. Although such homeostatic mechanisms are involved in goal-directed behaviours and mechanisms, they are fundamentally different.

> The dog pricks up his ears, jumps out of the door, down the stairs and welcomes his master in boisterous jumps - a whole sequence of goal-directed activities. Yet in what possible sense could each of them be thought of as a physical system returning to a state of stable equilibrium (except perhaps in the completely trivial sense in which any state of activity is defined as a state of disequilibrium and any state in which the activity ceases as a state of equilibrium)? (Sommerhoff, 1969, pp. 196-197)

In addition, people are usually multi-goal-directed (Ackoff & Emery, 1972), with conflicts frequently arising between these goals (e.g. Emmons & King, 1988; Peterson, 1989). In this case, where very complex systems are considered, the idea of an equilibrium makes little sense. Even where it is assumed that a particular equilibrium may potentially exist and is being sought, the large variety of ways in which this state can, through the principle of equifinality (von Bertalanffy, 1950) be attained from a number of starting points, means the simple negative feedback loop, or homeostatic mechanism, cannot alone account for more complex sequences of behaviour.

While a complex system may be composed of units which operate according to particular mechanisms, the placing of many units together, perhaps loosely coupled and on different levels, such that they interact with each other and with the environment, means that the mechanisms underlying the operation of the whole system are unlikely to resemble those of the units of which it is composed. Control loops, simple systems, and homeostatic mechanisms are like building blocks: While they may dictate to some extent the form or structure, the function of the system will fall under other influences.

Despite these potential dangers, the general example given of the architect and the task completion goal X, shows how an action/goal theory approach encompasses many areas of psychology and human activity. Such an approach, for example, has been used in the analysis and description of animal behaviour (Schurig, 1985), motor activity (Neisser, 1985; Stadler & Wehner, 1982), social cognition (Silbereisen, 1985), social interaction (Von Cranach & Kalbermatten, 1982), occupational psychology (Broadbent, 1985; Hacker, 1985; Lee et al, 1989; Wolff, 1982) clinical psychology (Semmer & Frese, 1985). As such, action theory is a metatheory of human behaviour, making possible a common interpretation of specific theories under a single perspective. However, action theory has had a particularly strong influence on one area psychological research, motivation, which is particularly relevant to stress phenomena.

Motivational control theory

Stress phenomena, and in particular life events, are described by their proponents as stimuli which encourages a view of those who experience these phenomena as passive and even victim-like. Stress phenomena of this sort are seen solely as things that happen to people. While some situations do involve things that happen to people, the vast majority of stress phenomena occur in the context of active striving. Stress phenomena are a part of this process. In addition, people knowingly put themselves in situations where such phenomena are likely to occur. This is however more fundamental than sensation seeking. Reversal theory (Apter, 1989) suggests that two metamotivational modes, telic where the goal is primary, and paratelic where the activity is primary, can be distinguished. In paratelic mode the architect's primary reason for continuing with X is the activity of continuing with goal X, in itself. If one could offer to instantly provide a completed building, the architect would still prefer to continue with the activity. Apter (1989) argues that much human activity and motivation is of this sort. Personal projects, creative work, or problems which are involving, do contain goals, but can be viewed as motivated primarily by performance of the activity. In the same way as most stress phenomena can, as discussed above, be subsumed under the general heading of adaptation, these phenomena can be also interpreted in the context of general theories of motivation.

Notions of homeostasis and dynamic equilibria have probably always played a part in contributing towards an understanding of human behaviour and motivation (Cofer & Appley, 1964). More recently, control theory and action theory, as refinements of homeostatic theories, have become increasingly popular in accounts of motivation (e.g. Hyland, 1988; Klein, 1989; Pervin, 1989; Sorrentino & Higgins, 1986).

Hyland (1988) discusses five components of motivational control theory with reference to a single negative feedback loop. These are reference criterion, perceptual input, detected error, error sensitivity, and direction and intensity of behaviour. Each of these will be discussed in turn. Where possible and necessary, the example of the architect will be used to illustrate aspects of these components. A reference criterion, discussed earlier, is defined here as "an internal standard against which all comparisons are made" (p. 643). Four categories of reference criterion are distinguished: First, an end state, which in the case of the architect was the completion of goal/task X; second, rate of progress towards an end state; third, a reference criterion could be a particular type of action, "about doing or being rather than actually attaining a particular end state...a person may have a goal of achieving...rather than achieving a particular object..." (p. 643), which in the case of the architect the reference criterion may have been to follow orders in general; fourth, an emotion or particular mental state could also be a reference criterion.

The second component is perceptual input. Three kinds of input are discussed. First, the perceptual input could be part of the situation. This input would be used mainly with the first and second type of reference criteria to assess the nearness of the desired end state. Second, the perceptual input could come from the actions of the person. The architect could use such an input to detect whether or not they were following orders. Third, the perceptual input could derive from internal thoughts and feelings.

Hyland (1988) describes detected error, the third component of the theoretical account of a negative feedback loop, as a phenomena which "selects and energizes a particular behaviour which tends to eliminate the difference between the reference criterion and perceptual input" (p. 643). Both approach motivation and avoidance motivation can be incorporated, but goals in each of these orientations have separate control loops. The architect may want to follow orders (approach motivation) and avoid disobeying orders (avoidance motivation). In each of these cases separate control loops are necessary. What was implicit in the above discussion is made explicit here. "A person may enjoy the elimination of detected error and dislike any increase in detected error" (p. 643).

The fourth component within this framework is error sensitivity, which helps to account for the intensity, and perhaps the amount of goal-oriented behaviour. Error sensitivity refers to the salience of a particular goal. Hyland gives the example of different sensitivities to keeping communal living areas clean: Two people may both want the room to be clean, but if their error sensitivities are different it is likely that one person will put more effort into cleaning than the other. Hyland suggests that different levels of error sensitivity may exist for positive and negative goals, or for emotional as opposed to non-emotional control loops. Although not discussed here, error sensitivity may help to explain how, given the potentially overwhelming number of detectable errors, attention is focussed, or particular errors are selected for discrepancy reduction.

The fifth component of this theory accounts for direction and intensity in a single control loop. Direction can be understood in terms of the reference criterion, while intensity of behaviour is a function of both detected error and error sensitivity.

Understanding the role of a single negative feedback loop is considerably easier than understanding the numbers and workings of feedback loops involved in the performance of even a relatively simple behaviour. As emphasised above, caution is required in using such analogies. However, there appears to be considerable potential for using this approach to integrate existing knowledge and to generate further inquiry (Hyland, 1988). Some examples of the applications of this broad approach to behaviour generally, behaviour at work, and behaviour in computer-supported work will be briefly discussed.

Goal-directed behaviour in life in general

Despite many theoretical difficulties (Montefiore & Noble, 1989), there is little doubt that people behave as though they have goals, particularly when lower level goals are considered. Research on action identification (Vallacher & Wegner, 1987, 1989; Wegner & Vallacher, 1986) suggests that these goals are arranged in a hierarchical order. When people have a number of identities available to them to describe a particular action or the performance of that action, they tend to choose a higher level identity. In addition, when performance of an action is difficult or unfamiliar, or when negative performance feedback is given, lower level identities tend to be used (for example, 'writing a thesis' or 'writing a paragraph').

Higher level or superordinate goals have more recently been referred to as personal strivings (Emmons, 1986, 1989; Emmons & King, 1988, 1989), life tasks (Cantor et al, 1987; Cantor & Langston, 1989; Zirkel & Cantor, 1990), and in the context of understanding the concept of the self, as ego tasks (Greenwald & Pratkanis, 1984). (It is worth noting that the recent surge of interest in goal concepts in human behaviour has taken place in the context of late 20th century views of selfhood, where the self is to a greater extent than in other historical periods defined and fulfilled by individuals personal achievement of goals (Baumeister, 1987)).

Understanding of the origin and organization of goals in the case of higher level goals presents many more difficulties than in the case lower level goals (Blankenship, 1985). Returning to a previous example, the origin and organization of the architect's goals in the activity of ordering materials for the foundation of the building is reasonably clear: In order to build the building, the foundation must be laid, which requires certain quantities and types of materials to be ordered. This requires the writing of letters to suppliers, the composing of the letters, and so on.

However, a clear picture does not emerge when we consider the origin and organization of some of the architect's higher level goals of doing a good job, following orders, or pleasing people. It is likely that the architect is unaware of the goals which are superordinate to these: Unconscious, in the sense of unaware or inaccessible (Nisbett & Wilson, 1977), and/or symbolic, in the psychoanalytic sense, they are likely to play an important role in, say, error sensitivity, the structure of lower level goals, and in the nature and intensity of affect surrounding goal-oriented activity. Despite the lack of clarity in conceptualizing higher level goals, recent research has suggested that the structure of these goals may have implications for well-being. Emmons & King (1989) found that those with more differentiated striving systems displayed higher levels of emotional reactivity, and that conflict between strivings was associated with lower levels of psychological and physical well-being (Emmons & King, 1988).

That people are goal-directed in their life in general has theoretical and intuitive appeal, and plays an important part in the creation of coherent narratives which shape and identify the self (Gergen & Gergen, 1988). In general it is possible to obtain a clearer interpretation of low level goals and actions than higher level goals and actions.

Goal-directed behaviour in work

At work, the notion that people are engaged in goal-directed behaviour not only has theoretical and intuitive appeal, but is explicit in social, political and economic views of the nature of work. In particular, reductionist approaches to the functioning of economic production systems and organizations, such as Taylor's (1911) scientific management, make use of goal-directed principles. However, these goals are not viewed as existing within workers or in a relationship between the worker and their environment, but within production systems or their agents, managers. Hence the aims of such an approach is to maximise output and efficiency. With the decline in popularity of Taylorist views there has been a shift in emphasis away from the view of economic organizations as ordered, rational systems towards a more critical appraisal of, for example, the contradictions and conflicting goals within organizations (e.g. Katz & Kahn, 1966), the different goals and adaptive strategies used by different organizations (Miles & Snow, 1978), and the variety of metaphors such as organismic, or brain-like, which can be used in addition to the mechanical metaphor epitomised by Taylor, to describe and interpret organizations (Morgan, 1986).

There has also been a move towards considering individual and group goals in behaviour at work. While research into German action theory has tended to focus on very low level individual goals within a framework of experimental cognitive psychology (and ergonomics/human factors research) (e.g. Hacker, 1982a, 1982b, 1985; Kluwe & Friedrichsen, 1985), American approaches have widely applied motivational control theory to goal-setting as a motivational technique to increase performance in the work place (e.g. Hollenbeck & Williams, 1987; Kernan & Lord, 1990; Lee et al, 1989; Locke & Latham, 1984; Locke et al, 1981; Mitchell & Silver, 1990). Here, higher level goals, such as work task goals, are considered on both an individual and group level. An intention of this approach also, like that of Taylorism, is to increase performance.

Lee et al (1989) describe two main attributes of goals, content and intensity. Goal content has at least four dimensions: These are difficulty, specificity, complexity, and conflict (the latter referring to the extent to which attainment of one goal precludes attainment of another). Goal intensity refers, for example, to the commitment and importance given to the goal. Hard (as opposed to medium or easy) and specific goals lead to higher levels of task performance.

While action theory approaches have been used to develop motivational techniques, little research has apparently been conducted on individual antecedents of goals at work. While it is usual for people at work to have goals set externally or situationally, many aspects of goal content and perhaps to a greater extent goal intensity are formed by features the individual brings to the situation such as higher level goals.

<u>Goal-directed behaviour in computer-supported work</u>

Human-computer interaction (HCI) research has for some time viewed the actions of a user as goal-directed, though early approaches viewed these goals on a very low level (Card et al, 1980, 1983; Newell & Card, 1985), prompting the criticisms that such an approach was extremely limited, at too low a level (Carroll & Campbell, 1985), and that it represented "cognitive Taylorism" (Frese et al, 1987, p. v). More recent approaches to HCI (e.g. Norman &

Draper, 1986; Carroll, 1987) have attempted to take a broader view of the goals users have, and of the processes involved in using a computer. In particular, the work and social context of computer usage has been considered, (Bannon, 1985, 1986; Brown & Newman, 1885; Norman, 1986; Suchman & Wynn, 1984). The difficulties experienced by users can be described in terms of discrepancies between the goals of the user and the physical state of the computer system, so creating gulfs of evaluation and execution between the user and the computer system. Activity theory (which though sharing a similar philosophical background to action theory, places greater emphasis on sociological and anthropological methodologies and levels of analysis) has been explicitly adopted by Suchman (1987) and Bodker (1989) in their studies of HCI.

While there is increasing emphasis on studying HCI in work contexts, and considering the goal-directed nature of users' activities, much of this research is oriented towards design issues. The starting point and rationale for this research is to improve interface design rather than, say, to study computer-supported work in the context of occupational psychology. However, it is clear that activities in computer-supported work can be usefully viewed as goal-directed behaviour.

3.3.4 Conclusion: A theoretical framework of adaptive action control

By necessity, the preceding discussion has been limited: Not all parts of the framework have been presented, and those which have, received only limited treatment. What follows this section and this chapter will also be limited. As emphasised earlier, only particular parts of this framework can be described and empirically tested. Despite these limitations, the broad framework presented here represents an attempt to synthesize and integrate a wide body of knowledge about human behaviour and stress phenomena. In order to conclude this section the three main themes, adaptive, action, and control, used in the title of the framework will be briefly discussed. Then, some of its limitations will be discussed.

Adaptive

The framework starts with the notion of adaptation in order to emphasise a number of features of the phenomena which it attempts to describe and explain. The first feature of these phenomena is their ever changing flux-like nature. In contrast to this element of change is the element of stability and dynamic equilibrium, which is apparent in the second feature of these phenomena, systems. These phenomena arise from the functioning of many systems, which are coupled together in various degrees of looseness, and can be considered to operate over a variety of time frames. Like the weather, the nonlinear nature of these systems leads to a degree of indeterminacy, although predictions can be made about either general regulatory processes, or on the basis of long-term cyclical or other patterns of relationships between various parts of the system. The chaotic nature of these systems means that patterns of cyclical adaptive processes may produce sudden changes and be subject to subtle influences. It has recently been suggested that chaos may be a "new rationale for the possibility of free will" (Sappington, 1990, p. 23), a concept which forms the basis of the next element of this framework.

Action

The unit of analysis in this framework is action, and an assumption is made that much human behaviour is purposeful and goal-directed. These goals are partly organised on the basis of a hierarchy. Stress phenomena occur in the context of active, striving, multiple goal-oriented behaviour. Even where stress as a life event can be seen as happening to people, the event nonetheless enters a dynamic on-going system of goals, strivings, and actions. At the highest level, these goals can be considered to be unconscious. At the middle ranges, goals are conscious and can be articulated. At the lowest levels goals become sub-goals, used to guide the fine-grained execution of behaviour. The links between levels are not clear, and it is likely that behaviours shift from one part of the hierarchy to another, and even out of the hierarchy, depending on state and environmental conditions, and opportunistic behaviours.

Control

Control within this framework is maintained through the use of negative feedback loops which use reference criteria determined by goals. A discrepancy between a reference criterion and the current state will result in action which attempts to reduce the discrepancy. Considering discrepancies as motivational potentials removes some of the difficulties inherent in stimulus/response environment/person distinctions. This notion of control does not imply stability and maintenance, as the same motivational potentials produce the flux and change inherent in complex systems. Unlike homeostatic mechanisms in biology, it is action, not states, which are controlled in this framework.

Limitations

The most general limitation is that this framework is largely expressed on the level of an analogy borrowed from engineering and biological sciences: As such it is an incomplete metatheory. While efforts should be directed towards developing a more complete metatheory, at the same time specific lower level theories will be required to account for specific phenomena.

Like the phenomena this framework attempts to account for, it can itself be considered as organic, adaptive, and flexible. Various parts may be more or less loosely coupled depending on the evidence, either theoretical or empirical, which can be provided. It is certainly too simple, and sophistications or abandonments of parts will await further evidence. It attempts to reflect the nature of the phenomena it is attempting to explain, rather than fighting against the nature of the phenomena so that they will more easily fit into theories where they do not fit.

A further limitation of such a broad framework is that only very small parts of it can be examined. The parts which will be assessed in this thesis are those which relate to conscious short-term changes in stress phenomena, in particular affect, and awareness of discrepancies. In addition, limitations will be imposed by the applied nature of this research, and the constraints such research places on the range of methodologies which can be used.

3.4 Measurement and meaning of variables in a theoretical framework of adaptive action control

Given the broadness of this theory of adaptive action control (hereafter referred to the TAAC), the meaning and measurement of variables can only be understood in terms of what is not being measured: Any particular measure will only be able to indirectly tap a very small part of a complex ongoing process, where a huge number of variables are likely to be influential. A partial solution to this difficulty is to ensure that measures and methodologies are grounded in the theory they are attempting to evaluate. Even where methodologies are inadequate because of their limited scope, the theory can be indirectly tested by examining the validity of the measures used.

This section will discuss the meaning and measurement of selected variables in a TAAC. These variables will be selected on the basis of their theoretical and contemporary importance, their use in empirical research in this thesis, or both.

3.4.1 Hassles

Mentioned above, in section 2.2.1, hassles have been become increasingly popular as measures of life stress. The term hassles has popular usage, but earlier research into everyday minor difficulties and problems shows that psychological interest has existed for some time: Cason made a study of common annoyances (1930a, 1930b, 1930c), Rehm (1978) examined the effects of pleasant and unpleasant events on mood, and Lewinson and colleagues looked at the relationship between unpleasant events and depression (Lewinson & Talkington, 1979) and developed an Unpleasant Events Schedule (Lewinson et al, 1983). Indeed, Cason's keen desires for the future study of common annoyances, are only now beginning to be fulfilled:

> A detailed investigation could be made of the most prominent annoyances that are present in several occupational activities in industry. What is the influence of these annoyances on the efficiency of the worker, and what practical steps could be taken to eliminate them? To what extent is industrial fatigue due to the presence of these annoyances, and how are the two subjects related to each other? (Cason, 1930a, p. 235)

Modern research on daily hassles has typically asked respondents to indicate retrospectively over a period of weeks or a month the extent to which items were a hassle (DeLongis et al, 1982; Ivancevitch, 1986; Rowlison & Felner, 1988; Kanner et al, 1981; Wolf et al, 1989). Hassles have been described to respondents as "minor irritants that can range from minor annoyances to fairly major pressures, problems, or difficulties" (Kanner et al, 1981, p. 24) and "irritants - things that annoy or bother you; they can make you upset or angry"

(DeLongis et al, 1988, p. 495). This retrospective method of assessing hassles is partially in conflict with approaches described in the TAAC because of the difficulties in interpreting such distal events, and their possible relationships with general health outcomes.

However some studies have examined the relationships between events assessed on a daily basis and mood, (Bolger et al, 1989; Caspi et al, 1987; Clark & Watson, 1988; DeLongis et al, 1988; Neale et al, 1987; Stone, 1987; Stone & Neale, 1984), and between daily events and physical symptoms (Stone et al, 1987c). Within this framework, hassles, minor life events, or daily stress, take on the status of environmental stressors. Whilst the methods adopted, and the use of daily diaries, fit well with the TAAC, the conceptualization of these phenomena, as external or environmental does not.

Within a TAAC daily hassles represent a variety of configurations of discrepancy within negative feedback loops. A necessary precondition of a hassle can be considered to be a conscious awareness of a discrepancy between a reference criterion for a goal and a current state or situation. However, as such discrepancies occur very frequently, a discrepancy is a necessary but not sufficient condition for the occurrence of a hassle. The extent to which this awareness is accompanied by negative affect such as feelings of upset or annoyance, depends on appraisal processes (see section 3.4.2 below), and the effects of goal-directed, or discrepancy reducing actions. If the discrepancy is large, or unexpected, or particularly threatening, or if it is anticipated that discrepancy reducing actions will be difficult or unsuccessful, for example, then the situation is more likely to be viewed as a hassle and appraised negatively. If actions are taken to attempt to reduce the discrepancy, then feedback which indicates that the discrepancy is not being reduced is also likely to increase the extent to which the situation is viewed as a hassle.

Within the TAAC the conscious awareness of discrepancies which may cause situations to be seen as hassles, can be viewed in the context of the distinctions which have been made between controlled and automatic information processing (e.g. Shiffrin & Schneider, 1977) and similar distinctions which have been made between willed and automatic control of behaviour (Norman & Shallice, 1986). Relatively skilled, automatic and unconscious closed loop action control, in contrast to open loop conscious action control, may underlie the differences between discrepancy reducing behaviours which constantly occur and, because of their automatic unconscious nature are not viewed as hassles, and discrepancy reducing behaviours which are controlled consciously, and perhaps effortfully. While hassles within a TAAC cannot be thought of as environmental stressors, they do provide a useful way of assessing on a daily basis, conscious awareness of discrepancies which have a affectively negative evaluation.

3.4.2 Affect

The last decade has witnessed a rapid and widespread surge of interest in the measurement and conceptualization of affect, leading Watson & Tellegen (1985) to remark that "psychology has rediscovered affect" (p. 219). Affect is more closely related as a system to, say, hassles or discrepancies, than are physical or psychological symptoms. The link between an affective state, and attaining or not attaining a goal, is both intuitively and theoretically supported. The theoretical meaning of affect in relation to the TAAC will be discussed later in this section. First though, the measurement of affect will be discussed.

One of the major difficulties in the assessment of affect or mood is establishing, either theoretically or empirically, a structure for affective experience, and relating this structure to other psychological phenomena. For example, questions concerning the numbers of affective dimensions, and how these dimensions may relate to more stable dimensions of personality or behavioural traits are fundamental to the measurement of affect. The structure of affect has been widely conceptualized within two-dimensional space on two bipolar axes (displeasure/pleasure and level of arousal), with adjectives describing mood states spread in a circle round these axes (e.g. Russell 1979, 1980). The debate and research into the number, independence of, and content of the factors which best represent the experienced structure and process of affect has been considerable (Diener & Iran-Nejad, 1986; Diener & Emmons, 1984; Gotlib & Meyer, 1986; Warr et al, 1983; Watson, 1988a; Watson & Tellegen, 1985; Zevon & Tellegen, 1982).

Watson & Tellegen (1985), reanalysing their own and others' previously collected data on self-reported mood, concluded that the two independent factors, positive affect and negative affect, which consistently emerged after orthogonal varimax rotation, represented the "basic structure of mood at the major factor level. This is not to suggest that all disagreements have been resolved. Researchers still argue over the optimal rotation within the basic two-factor space, and, hence, the best way to conceptualize the principal dimensions of mood" (p. 231).

Within this framework, high positive affect (PA) is described by adjectives such as excited, active, alert, while low positive affect is described by adjectives such as tired, sluggish, depressed. Watson (1988a) has described PA as a dimension which "reflects one's pleasurable engagement with the environment", while negative affect (NA) "is a general factor of subjective distress" (p. 128). High levels of NA are characterised, for example, by mood states such as nervous, angry, guilty, and low levels by calm and relaxed. Low levels of both PA and NA reflect the relative absence of affect.

Affect has already been briefly discussed in connection with the TAAC, and in most of the examples thus far given, the description of affective experience only in terms of two dimensions, NA and PA, which would seem to be inadequate. However, other evidence for this two independent factor structure can be found in the relationships between negative and positive affect, and measures of personality and dispositional variables (Meyer & Shack, 1989; Warr et al, 1983; Watson & Clark, 1984).

Debates about the structure of affective experience are likely to continue for some time, and will remain important for a TAAC. However recent trends in the assessment of affect (mirroring those which have taken place in hassles methodology), from retrospective monthly or weekly assessments to daily assessments, increase the possibility of examining affect in the context of TAAC. The relationships between daily measures of positive and negative affect, health complaints, perceived stress, and daily activities have been examined (Watson, 1988a), as have the relationships between daily affect and daily life events or hassles discussed in the previous section, though most of these studies (Bolger et al, 1989; Caspi et al, 1987; DeLongis et al, 1988; Neale et al, 1987; Stone, 1987; Stone & Neale, 1984) used different measures of affect to those discussed in this section. Other research on daily affect which corresponds with the TAAC has examined individual variability in daily mood (Larsen, 1987), and seven day cycles in mood fluctuations (Larsen & Kasimatis, 1990).

In addition to the recent trends in methodology which can be seen in the context of the TAAC, a number of approaches to theories of emotion make use of goal concepts. On a general level, telic theories of subjective well-being (see Diener, 1984) argue that attaining a goal or a state tends to promote happiness. On a level more specific to emotions, goal concepts have been incorporated into a variety of theories of emotion (e.g. Carver & Scheier, 1990; Frijda, 1985, 1987; Oatley & Johnson-Laird, 1987; Ortony et al, 1988; Sloman, 1987; Weiner, 1986; Weiner et al, 1979).

Some of these theories share much in common with the TAAC presented here. Carver & Scheier (1990) for example take a control-process view to positive and negative affect: They suggest that in the process of discrepancy reduction a standard for the rate of discrepancy reduction operates in a metamonitoring loop. Hence, positive affect is produced when discrepancy reduction is proceeding at a higher rate than the standard, negative affect in the opposite condition, and progress at the expected rate results in no affect. Oatley & Johnson-Laird (1987) argue that emotions "provide a biological solution to certain problems of transitions between plans in systems with multiple goals" (p. 29). Happiness is the result of the achievement of subgoals and sadness the result of the failure of a major plan or loss of an active goal. In addition to happiness and sadness, they posit the existence of three other basic emotions, anxiety, anger, and disgust, which are connected with self-preservation goals, active plans, and gustatory goals respectively.

While the measurement of affect as NA and PA may be at too gross a level for full incorporation into the TAAC, the relationship of these dimensions to other variables suggests that they are important. On the level of meaning, the place of affect in the TAAC, particularly in relation to theories of emotion is a little clearer.

3.4.3 Adaptive behaviours

Within the TAAC a wide range of behaviours can be considered to be adaptive. Indeed, it emphasises the adaptive goal-oriented nature of behaviour, almost all behaviours can in some way be viewed as adaptive. Here, examples will be given of the measurement and meaning of two kinds of variable which are particularly relevant for the TAAC; individual differences which may influence the expression and style of adaptive behaviours, and one particular category of adaptive behaviours, coping.

Individual differences and adaptive behaviours

Individual differences in adaptive behaviours within a TAAC can be readily conceptualized as stylistic thought or action tendencies in motivation and behavioural control. However, given the complex system properties of the TAAC, the level on which these individual differences are operating, such as perceptual, learned response set, or biological, is unclear and perhaps unimportant. The principle of equifinality in living systems (von Bertalanffy, 1950) discussed above, means that a response may be produced in a variety of quite different ways, through different processes. Responses may, on the level of observation or measurement, be identical, however the process of equifinality means that the nature of these responses may be quite different.

An example of the multiple levels on which individual differences in adaptive behaviour may operate can be found in the recent interest in the measurement of optimism and pessimism (e.g. Dember et al, 1989) and pessimistic explanatory style (Peterson et al, 1988). The theoretical foundation for this research can be found in previous work on social learning (Bandura, 1977), locus of control (Rotter, 1966), and learned helplessness

(Abramson et al, 1978, Seligman, 1975). Relationships have been found between locus of control and measures of optimism and pessimism (Dember et al, 1989), between measures of optimism and problem-focused coping (Scheier et al, 1986), and optimism and symptom-reporting (Scheier & Carver, 1987). Relationships too have been found between pessimistic explanatory style, which is the tendency to explain negative events using stable, global, and internal causes, and physical illness in both the long-term (35 years, Peterson et al, 1988), and short-term (the following month, Peterson, 1988).

Closely connected to the notion of optimism and pessimism is negative affectivity, already discussed as an individual difference in Chapter Two. Other individual differences in affective variability have been conceptualized as the typical level of intensity with which affect is experienced. This has been described as affect intensity (Larsen et al, 1986) or emotionality (Aldwin et al, 1989). Although both of these variables, fit within the TAAC on a general level because of their clear relevance to affect and variability or stability of affect as a process, problems are encountered in their incorporation within the TAAC on a more specific conceptual level.

Returning to the single negative feedback loop and some of the theories of emotion described above, it is difficult to interpret exactly where within these systems the tendency to experience negative affect or affective intensity originates. For example, an individual may experience chronic levels of negative affect because their goals or reference criteria are high, and they therefore never attain goals. On the other hand, it may be because their comparator is very sensitive, or the signal is heavily amplified. On another level, it may be the case that the individual that a lack of correspondence exists between a high level goal and medium level goals, such that the attainment of medium level goals leaves discrepancies unchanged on higher levels. On this same level, it could be that the individual operates within a very narrow hierarchy such that their self-system, as partly described by the hierarchical structure of goals, is insufficiently complex to allow for movement from one high level goal to another (see Linville, 1987).

Coping

Problems with conceptualizing individual difference variables within the TAAC extends to a particular category of adaptive behaviour, coping. The distinctions made between different types of coping behaviours, which may be differentially related to adaptational outcomes, are difficult to absorb directly into the TAAC. Some recent examples of measures of coping show considerable variety in the distinctions made between coping behaviours. Carver et al (1989) make distinctions between ten types of coping behaviour including, for example, planning, seeking instrumental social support, and mental disengagement. Stone & Neale (1984a) describe coping within nine categories, two of which are religion and catharsis. Dewe & Guest (1990) use five categories, including emotional release. Latak (1986) describes three categories including symptom management. Rohde et al (1990) also identify three categories, one of which is labelled ineffective escapism. While these differences exist in some conceptualizations of coping behaviours, there is considerable agreement that active coping behaviours can be broadly thought of as either emotion-focused or problem-focused (e.g. Billings & Moos, 1981, 1984; Endler & Parker, 1990; Folkman & Lazarus, 1980; Hamilton & Fagot, 1988; Pearlin & Schooler, 1978).

Neither general categorical approaches, or the emotion versus problem-focused dichotomy can be readily interpreted in the context of the TAAC, either as styles of adaptive behaviour, or as descriptions of adaptive behaviours per se. The strong influence of situational factors such as perceived controllability (Averill, 1973; Folkman, 1984; Folkman et al, 1986a, 1986b; Parkes, 1984), type of event (McCrae, 1984; Mattlin et al, 1990), or resources (Holahan & Moos, 1987) on coping suggests that these behaviours as currently conceptualized cannot either be traits or, in the process view of adaptation within the TAAC, adaptive behaviours. An adaptive behaviour is likely to contain both emotion and problem focused elements. Indeed, process-oriented approaches to the study of coping (e.g. Folkman & Lazarus, 1985; Pennebacker et al, 1990) explicitly suggest that adaptive behaviours change over time. On a more fundamental level, it could be argued that all adaptive behaviours are, say, emotion focussed, in that they are all oriented to the same end, an affective state. The way adaptive behaviours can be described also depends on the motivational theory which underlies these descriptions.

In order to be incorporated into a TAAC, coping must, like the variables already discussed here, be conceptualized as adaptation, within a negative feedback loop. Although adaptive behaviours do not clearly start or stop, and a great deal of coping is unconscious and automatic (indeed it could be argued that although coping is typically conceptualized as a response to stress, it is actually a response to the failure of automatic coping to maintain certain dynamic equilibria), the idea of coping as discrepancy-activated, can be useful.

At the point of conscious awareness of a discrepancy such as a hassle, (here more frequent everyday adaptive behaviours will be discussed, rather than those made in response to extreme and infrequent events, such as bereavement) adaptive behaviours, which remove or reduce the discrepancy, are those which are directed towards disengagement from the current control loop, or engagement with the current discrepancy in the current control loop.

Disengagement from the current control loop could be attained by either moving to another control loop, or by moving completely out of influence of control loops, or any planning or fantasy potentially connected with a past or future discrepancy or states, which would involve almost total disengagement.

In essence, this latter way of disengaging from the current control loop is the equivalent of the complete absence of the four elements (present state, future state, discrepancy, and action alternatives) which are used by Kuhl (1981, 1982, 1985) to distinguish between action and state orientation. In Kuhl's distinction, the absence of any one of these elements indicates state orientation, while the presence of all four indicates action orientation. Disengagement from the current control loop and moving to another is presumably facilitated by switching from action to state orientation, as the values of other future states are considered, or plans are formulated. This switching process may operate in both sequential and hierarchical actions. In a sequence of actions, moving from one sub-task to another (e.g. in the example of the architect from ordering building materials, to preparing the site for their delivery), presumably requires switching from action to state orientation. In a hierarchical organization, movement towards a goal such as becoming a good architect, can be achieved in a number of ways (equifinality), and therefore if one sub-goal (e.g. the current design becoming an award-winner) fails, efforts may be switched to another (e.g. becoming active in a professional architect's association).

For these reasons, disengagement from the current control loop should not be viewed as in some way negative, in the same way as engagement with the current control loop should not be viewed as positive. Disengagement and engagement are neutral, and in themselves non-predictive with respect to outcome, as many other aspects of the situation need to be taken into account.

Continued engagement with the current control loop involves adaptive behaviours which reduce the discrepancy in one of three ways: By reducing or changing the reference criterion (e.g. giving oneself more time to reach a goal), by maintaining the same goal and the same behaviour (e.g. performing the same activity, but making more effort), or by maintaining the same goal but adopting different behaviour (e.g. by adopting a new strategy). This distinction between adaptive behaviours is quite general, and could be applied to many systems on a number of different levels over different time frames (e.g. Miller, 1978). In this case, longer-term adaptive behaviours may involve, say, reducing error sensitivity, or learning new skills.

The incorporation of coping measures into a TAAC requires that more information is collected about the person reporting the coping behaviours, the meaning of their behaviours in the context of their goal hierarchies, and equally important, the situational constraints and determinants of specific behaviours. Without this knowledge, such behaviours cannot be interpreted, and traditional distinctions, such as that made between problem and emotion focussed coping, make little sense. In addition, more integration is required between coping theory and theories of emotion (e.g. Folkman & Lazarus, 1988), and coping theory and action theory (e.g. Frese et al, 1987; Herrmann & Wortman, 1985; Kuhl, 1981, 1985; Schonpflug, 1985).

Despite the brief nature of this discussion, some indications have been given of how adaptive behaviours can be usefully incorporated into the TAAC presented here: Like the other variables thus far discussed, their meaning and measurement is at a rather different level from that suggested by current conceptualizations of adaptive behaviours.

3.4.4 Context

The measurement and meaning of this type of variable in the TAAC refers to how characteristics of the environment can be assessed, and what such assessments mean. As indicated a number of times, the notion that the environment and the person are separable rests uneasily within the TAAC, which takes as its starting point a discrepancy which does not exist within or between the person and/or environment, but on a different level of abstraction. In Chapter Two, environmental or contextual variables were placed into a number of categories; social support, extrinsic job characteristics (e.g. the physical environment, interpersonal contact), nonwork demands and characteristics, and intrinsic job characteristics. Rather than discuss all of these, a general example of the meaning and measurement of context in TAAC will be given by using the case of a number of intrinsic job characteristics.

Most measurements of job characteristics, as discussed earlier, are subjective, and therefore contaminated by individual 'bias'. Within the TAAC such biases are not contamination, but an important part of the process by which job characteristics can influence and be influenced by the individual. It is clearly important, in a general sense, to include both objective and subjective measures of job characteristics, and the discrepancy that may exist between them, as described in the person-environment fit model (e.g. French et al, 1981).

In the TAAC, however, it is not the discrepancies themselves which influence, for example, affect, but the meaning of these discrepancies. A number of examples illustrate this approach. Fineman & Payne (1981) showed that role conflict and role ambiguity were related to strain only where these characteristics were viewed as threatening. Payne et al (1988) argue that "any aspect of the work environment might have positive or negative consequences for some people" (p. 157). In the case of measures of the social environment at work (e.g. intimacy, support) Repetti (1987) has shown that individual and common perceptions (based on consensual ratings) of social environments may influence mental health, but it is the more proximal individual perception which has a greater effect. James & James (1989) suggest that the meaning of work environment attributes can be ordered hierarchically, and that judgements of the significance of particular characteristics for well being are partly based on that particular characteristic, but more strongly on a general perception of "the degree to which the individual believes that membership in this work environment is personally beneficial versus personally detrimental to his or her organizational well-being" (p. 740).

These examples demonstrate that questions about the relationships between objective and subjective measures have become considerably more sophisticated and many difficulties remain (Frese & Zapf, 1988). In general, distinctions between objective and subjective and between environment and person are being examined more closely. In measurement terms, asking both for an assessment of characteristics, and an assessment of their importance or affective meaning would seem to be a minimal requirement.

However, traditional characteristics (e.g. autonomy, intimacy, ambiguity) can only be understood in terms of the TAAC by considering the extent to which these influence the possibility of attaining work goals and reducing other discrepancies. For example, how does a job with a high degree of autonomy influence the goal-setting processs and the possibilities of attaining such goals? Whilst certain empirical findings, such as the positive relationship between job demands and strain when levels of autonomy are low (Karasek, 1979), can be readily interpreted within the TAAC (a high number of goals, with little choice about how to attain them is likely to lead to more and more intense discrepancies), a more theory-based type of measurement is required in addition to the assessments of meaning.

Measurement could involve the use of individual weightings of both personal importance and importance to the job and job tasks. In addition, the extent to which the job characteristic facilitates or hinders the attainment of personal and job goals is likely to be important. In the case of autonomy, the individual may prefer higher levels, even though the nature of the work does not require higher levels of autonomy. In such a situation, it may be that high levels of autonomy actually make meeting job goals more difficult. Many of these personal goals at work could be relatively high level, such as the need to be in control of others, or the desire to be seen as fair. Job variety in relatively complex jobs, for example, could likewise be interpreted with a TAAC. In jobs where tasks are organized in a strictly sequential way, the possibility of reducing discrepancies outside the current control loop is extremely limited. A more hierarchical organization of job goals, gives the possibility of movement from one discrepancy to another, and greater likelihood of successful discrepancy reduction. Another measurement issue in jobs which have separable tasks, is the extent to which a single measure of a job characteristic, such as workload, can be generalized across different work tasks: In such jobs, separate assessments for different tasks may be required.

In essence, as with measures of adaptive behaviours, the incorporation of measures of context into a TAAC, allows a more ready interpretation of both their facilitating or hindering aspects in the movement towards goals, and equally importantly, their affective connotations.

3.4.5 Well-being, performance and effectiveness

One aspect of all these variables, affect, has already been discussed. While in the TAAC, affect is viewed as the central mechanism which underpins general well-being, performance, and effectiveness, measures of these variables may add useful information. While the more obvious suggestion is to always, where possible, measure a range of these variables (e.g. specific rather than general measures, individually reported and externally rated) this broad approach does not remove the problems of interpretation. In the measurement of these variables, as in contextual variables discussed in the previous section, the distinction between objective and subjective is both irrelevant and on another level important.

It is difficult to imagine what an objective measure of general well-being would involve. A claim that physical illnesses, or, say biochemical measures, are objective, is to assume interrelationships between different systems which are neither clearly demonstrable or well understood. While there is some understanding of the relationships between psychological phenomena and relatively short-term proximal physiological responses, there is little if any research which examines the relationships between these short-term changes and longer-term physical illness. Also, to assume that a physical illness is caused by low levels of psychological well-being is likewise without strong foundation. Whilst negative affect can produce illness behaviours (e.g. Mechanic, 1976; Salovery & Birnbaum, 1989), physical illness can also produce negative affect (e.g. Rodin & Voshart, 1986). On the other hand, taking different types of measures enables the relationships between so-called objective and subjective measures to be compared.

Whilst these will not be discussed in any detail here, similar difficulties can also be found in the measurement of performance and effectiveness. In short, all these measures must be assessed in the context of personal and work goals, and environmental context. For example, a high level of performance at one particular level is likely to have costs and consequences at other levels. A manager may be extremely productive in terms of physical output at the cost of failing to develop relationships with subordinates. What is probably more important is the extent to which these different goal spheres of performance are managed. Likewise, being effective in one domain, say concentrating on ones family, may have costs in terms of the time or effort remaining for other kinds of work.

In a TAAC, an understanding of these variables can only occur when considerable knowledge of the person's goal structure, aims, and motives are understood. Some people with certain traits, such as Type-A behaviour, may knowingly work in a way which provokes physical illnesses such as ulcers. For such people, ulcers are a cost they are prepared to pay for other benefits. Hence, the person who develops an ulcer unwillingly and unknowingly may have the same physical symptoms as a person who views it as a cost, but within a TAAC these physical signs of illness are not equivalent. Similarly with measures of performance and effectiveness; a knowledge of what the person is trying to do is essential to understanding what such information means.

3.5 Conclusion: A theoretical and methodological framework

A strong desire to avoid misrepresenting these phenomena has lead to the use of the weather metaphor, and the incorporation of elements of systems theory, and chaos theory in this framework on a quite general level. On a psychological level, it is through the same desire that concepts such as will, intention, and goal-directed action have been included. People behave as though they do have will and intention, and whilst it is essential that debate about these difficult concepts continues in psychological and philosophical inquiry, to ignore such phenomena is to deny what is perhaps the most defining feature of all human behaviour.

On a methodological level, measures such as affect, hassles, and adaptive behaviours, and methods, such as diaries and examining short-term patterns of fluctuations, lead quite directly from the framework presented here. The framework also challenges some of the premises of empirical practice, particularly those expressed through positivistic science. In this framework, cause and effect, stimulus and response, are difficult to separate, and prediction is less important than understanding. This again is a reflection of a desire to avoid misrepresenting the phenomena under investigation. Other kinds of phenomena, and temporally and conceptually proximal phenomena at more detailed levels within this framework, may be adequately characterized by cause and effect, stimulus and response, and prediction may then aid understanding.

One of the major drawbacks to this framework is that it can only be presented here in a very limited way, and the empirical work contained in the following chapters is also inevitably limited, and can act only as a partial demonstration of the potential, or lack of potential, which exists within this framework. It could be argued that any theory, or theoretical framework which cannot relatively easily be expressed and tested is somehow lacking. However, like action theory, or evolutionary theory, the framework outlined here represents an approach, or a way of looking at phenomena, rather than a concrete expression of assumed truth or fact waiting to be falsified.

The usefulness of this approach must be judged in the context of the goals which are set for theory and research, and the adaptive strategies adopted for reducing the discrepancies set up by these goals. In the case of stress research it has been argued here that its current goals are perhaps both unattainable and unimportant, and the strategies it uses are ineffective. What is required is not some minor alteration of these goals, or some refinement of strategy, but the adoption of a new set of goals which although they may be equally unattainable, ensure that the process of attempting to attain them is adaptive and responsive to the phenomena under investigation.

3.6 Summary

An examination of theoretical and methodological issues was undertaken in four stages: A discussion and critique of implicit theory, a discussion and critique of explicit theories of stress, a synthesis of theory using a rational approach to theory building, and an outline of the meaning and measurement of variables in this synthesis. Each of these stages will be summarised in turn.

Asking a series of specific questions, based only on the information so far presented about the variables in stress research, is a method of discovering implicit theory in stress research. Answers to questions such as what is stress?, where is stress?, reveal a strong implicit and informal medical model of health and disease, which leads ironically to a single-factor theory of disease causation in stress research. A second implicit and sometimes explicit theory is the engineering analogy. A third aspect of an implicit theory is varied time periods over which stress operates. A fourth aspect, is the idiographic and nomothetic approaches to the question of who experiences stress.

Each of these implicit theories or aspects of theory is also contradictory, suggesting that stress is not a single phenomenon, and involves more complex processes than either measures or the conceptualisation of the components of the phenomena suggest. The reasons for an absence of strong theory can be found beyond a critique of the measures and methodologies used. One of the central motivations for studying stress is that is it thought to be related to illness within a medical model of health and disease. This leads to repetitive replications of basic findings, and a narrowing of the focus of stress to disease.

The complexity and broadness of the phenomena which are studied, suggest that it is more accurate to consider that it is different types of adaptation in different systems, rather than stress, which is typically studied in stress research. This discussion of the components of the phenomenon of stress may not have directly contributed to a clearer understanding of stress, rather, it has suggested why, given current conceptualizations of stress, a clearer understanding of stress is difficult to achieve.

A discussion and critique of explicit theories of stress shows that there are quite a number of partial theories, designed to explain and interpret relationships between a few variables, but very few general theories of stress phenomena. The context for the development of these theories is one in which there is widespread agreement about the need for theory, but some doubt about the requirement for a general theory of stress. Such theories can be categorized as either largely descriptive or based on person-environment transactional theory. These general person-environment fit theories of stress do not appear to have influenced the practice of stress research, which is a partly a result of the abstract way in which many of these theories have been presented. In addition, incorporating this theory would undermine previous research and force current methods to be abandoned.

The inadequacy of these theories leads to the question of what the requirements for an adequate theory of stress would be. The first part of the answer to this question depends on what it is that such theory is attempting to explain, as an adequate theory should not misrepresent the phenomena under investigation. The previous interpretation of stress as involving adaptation, systems, and complexity leads to the conclusion that the phenomena under investigation can be described, like the weather, as chaotic systems. The second part of the answer, in an attempt to redress previous shortcomings of theory, is a requirement that the theory facilitates the development of methodology.

Given these requirements, theory building could progress in a number of ways. Here it is argued that a rational approach, based on broader philosophical principles rather than experiment and observation, offers more possibilities of meeting these requirements. Starting from a position of doubt reveals the general lack of knowledge about relationships and processes, and the partial knowledge about states and movements within states. The concept of adaptation links together most stress phenomena, but on quite different levels of analysis. It can be seen that much stress research tends to focus only on long-term levels of analysis which precludes assessments of adaptation and the regulatory processes involved. Control theory provides a useful way of describing these regulatory processes, and has been applied to a wide range of systems. The underlying mechanism of the negative feedback loop is relatively easy to conceptualize in the case of a single system. Problems arise however in interpreting the nature of the links between a number of systems, such as the psychological and the physiological. The idea of loose coupling removes some of the problems of mechanism and determinism in systems theory, and accounts for variability in stability and instability in systems. Problems remain however in defining and specifying the number of systems which describe stress phenomena. This highlights the potential dangers of using metaphors and analogies borrowed from other disciplines. Such issues cannot be resolved here, but they are partly avoided by focussing only on psychological systems, at a relatively microcosmic level, where definitions and distinctions are easier to make. Incorporating control theory into an interpretation of stress phenomena in psychological systems requires that the origin of discrepancies and the nature of control loops in these systems are specified.

Considering the goal-directed nature of human behaviour, taking action as the basic unit of analysis, leads quite directly to an understanding of how discrepancies arise within psychological systems. Action theory describes actions as directed towards the attainment of goals, which are, in the simplest description, organized hierarchically. Behaviour is guided by plans which aim to reduce the discrepancy between a current state and a desired state. These mechanisms and behaviours should not be confused with homeostatic mechanisms or behaviours which attempt to control states. In addition, that people are multi-goal-directed, and do not operate within single control loops means that the whole is considerably more than and different from the sum of its parts. Motivational control theory while adopting a similar starting point emphasises the ways in which goals are related to motivation. This is particularly pertinent to a traditional view in which individuals are seen to be passive victims of stress. Stress phenomena, particularly affect and psychological well-being can be interpreted in the context of general theories of motivation, as they arise in the course of goal-directed actions. The idea that behaviour is goal oriented has been applied to the study of human behaviour in life in general, in work, and in computer-supported work.

The overall framework produced from this synthesis and development of theory can be described as a theoretical framework of adaptive action control. The notion of adaptation is used to emphasise the ever-changing flux-like nature of the phenomena which it attempts to describe and explain, while at the same time emphasising the notion of chaotic systems which are characterised by variable stability, indeterminacy, and cyclical patterns of change. Actions which are usually goal-directed, are the unit of analysis. Stress phenomena occur in the context of these actions. Control is maintained through the use of negative feedback mechanisms which direct and organize action, but are not homeostatic mechanisms. The major limitations of this framework occur because it is based on an analogy, and is also a metatheory, requiring more specific theories at lower levels. A further limitation is that only small parts of it can be examined at any one time. In this thesis, affect and awareness of discrepancies will be used in an applied piece of research to partially examine the TAAC and its methodologies.

The meaning and measurement of five types of variables is discussed. Within the framework, hassles represent a variety of configurations of conscious awareness of a discrepancy in negative feedback loops. A discrepancy is a necessary but not sufficient condition for the experience of a hassle: The accompanying negative affect indicates that the discrepancy is one which in some way is construed as difficult to reduce. The second variable, affect, has recently received considerable attention. While the underlying structure of affect is and will continue to be the subject of some debate, recent methodological trends in examining affect changes on a daily basis fit closely with the TAAC. Theories of emotion also integrate well with the TAAC, as many of these view goals, and their attainment or non-attainment as central in the production of positive and negative emotions. The third type of variable, adaptive behaviours is considered in terms of individual differences and coping. Individual differences in a TAAC such as optimism and pessimism, negative affectivity, and affective reactivity can be interpreted in the context of different structures of goal hierarchies. Most categorical systems of coping behaviours do not fit particularly easily with the TAAC, but these are often not based on theory. Considering a single negative feedback loop, all coping behaviours can be viewed as discrepancy reducing, by either disengaging from the current control loop and moving to another, or continuing in the current control loop. In general much more needs to be known about what the person is trying to do in order to make accurate assessments of coping behaviours.

The fourth type of variable reflects the context in which action is taking place. In the TAAC, simple distinctions between the person and the environment, and between the subjective and the objective cannot be readily made. Using the example of intrinsic job characteristics, such as workload or complexity, these can be understood in terms of the extent to which they increase or reduce the possibility of attaining work and other goals. The affective meaning of particular characteristics is also important. Lastly, the measurement of general well-being, performance, and effectiveness, again raises the problems of distinctions between the person and the environment, and between objective and subjective. In the case of well-being, the mutually influencing nature of physical and psychological phenomena make the notions objective and subjective difficult to separate. Within the context of the TAAC, well-being, performance and effectiveness can only be understood in the context of what someone is trying to do.

The framework presented here has been produced by taking a rational approach to theory building, in response to the current failure of empirical approaches. If empirical work is to have meaning, it must take place in a framework such as that presented here. The growing recognition of the importance of integrating theories about motivation, affect, cognition, and action, has influenced the approach adopted here. An intense desire to avoid misrepresenting phenomena has led to the use of the weather metaphor, systems theory and the notion of chaotic systems. Some measures and methodologies can be interpreted very readily within this framework. Others cannot but have the potential to be incorporated. While cause and effect are difficult to interpret as a whole, more detailed parts of the framework, which contain proximal phenomena are open to such interpretations.

A drawback to this framework is that it can be presented here in only a limited way, and the empirical work which follows this chapter is inevitably constrained. While it could be argued that a framework or theory which cannot be easily tested is lacking, what is described here is an approach or a way of looking at phenomena rather than an expression of truth waiting to be falsified. The current goals of stress research are unattainable, often unimportant, and the strategies it uses are inadequate. A new set of goals may be equally unattainable, but they may at least ensure that the strategies used for reducing discrepancies can be adaptive and responsive to the phenomena under investigation.

PART TWO

The second part of the thesis contains three chapters (Four, Five, and Six) which report three empirical studies. As indicated in Chapter One and Chapter Three, it is not the purpose of these studies to fully, or even directly, test the theoretical framework presented in Chapter Three; this framework was intended as a contribution in its own right to theory development and not simply to support empirical work, in addition, its scope was such that it could not be tested in this context. The purpose of these studies then is to use some of the methodologies which can be derived from the theoretical framework in the empirical investigation of a particular research topic. In this way, some parts of the theoretical framework are indirectly assessed through the methodologies, and through the results provided by these methodologies.

Chapter Four begins with a brief literature review of symptom reporting in computer-suported work, which is the particular research topic under investigation in these three studies. However, few previous studies have investigated this topic, and only general evidence about the possible effects of using computers is available. The Chapter continues with a report of the first study, which is exploratory, cross-sectional, and based on more traditional questionnaire methodologies. This methodology was used partly because the study was exploratory, and so that variables of importance for use in future studies could be identified. In addition, it was used so that the information obtained using it could be compared with the type of information obtained from the methodologies derived from the theoretical framework used in the two subsequent studies.

Chapter Five reports the first of two studies which adopt diary methodologies incorporating measures of workload, work activities, hassles and affect. The unit of analysis in this study was a morning or an afternoon work session. The data were pooled, and all analyses were based on a work session. Chapter Six reports the second study which used similar measures, but in this study assessments were made on consecutive days and for many more measurement points. Lagged relationships could be examined, and the use of a much larger sample meant that both intraindividual analyses as well as pooled interindividual analyses could be carried out.

All the results presented in this Part of the thesis are discussed in two ways. First, the implications of these results for the research topic of symptom reporting in computer-supported work are described. Second, these results are discussed in terms of the methodologies adopted in each study. Broader discussion of these results as a whole, and their implication for the theoretical framework are discussed in the Chapter Seven, in the next and final part of this thesis.

CHAPTER FOUR

A CROSS-SECTIONAL STUDY OF THE DETERMINANTS OF SYMPTOM REPORTING IN COMPUTER-SUPPORTED WORK

4.0 Introduction

This chapter reports the findings from a study designed to investigate the psychological determinants of symptom reporting in computer-supported work. The term computer-supported work refers to office based work which involves the use of computers for specific tasks within a job, in contrast to work which is computer-based in which most if not all job tasks are performed through the use of the computer.

This study has two main aims. The first is to answer substantive questions about associations between symptoms and other variables, and to identify those variables for use in further investigations. This study is exploratory in that there is very little research which bears directly on the possible relationships between psychological variables and symptom reporting in computer-supported work, although there is a great deal of research which gives some indication of the type of variable which may be important. This research will be reviewed, though clearly not all possible variables of interest will be examined in this study.

The second aim is to examine some of the issues surrounding the use of traditional cross-sectional methodology in this type of research. Some of the limitations of cross-sectional methodology in stress research, such as their unsuitability for the study of processes, have already been discussed in Chapter Three. It is not the intention to repeat those criticisms here, but rather to assess the advantages and disadvantages of cross-sectional methodology in the study of symptom reporting in computer-supported work in particular.

4.1 Symptom reports and computer-supported work

A large number of factors may determine the level of symptom reporting associated with any environment. The general headings for these different types of factors can be found in any of the more descriptive models of occupational stress (see Chapter Three). In computer-supported work there may be additional factors, or unique combinations of factors which arise from using and having a computer at work.

4.1.1 Human factors

It is probably within the area of human factors research that the general public was first alerted to the possibility that the use of computers at work may have negative effects on the health of those who use them. While initially this research focussed on aspects of the computer hardware, such as visual display units (VDUs) and input devices, more recently various characteristics of software have been studied in relation to operator symptom reporting.

Hardware and software design have obvious implications for users. However, such effects will be more apparent in those engaged in more intensive computer-based, rather than computer-supported work, and those whose work possesses characteristics which are related to symptom reporting in any work. For example, as Armbruster (1983) has pointed out, in some university research and software development environments, which may involve intensive computer use, human factors considerations have almost been ignored with no apparent negative effects on users. In contrast, data entry employees engaged in very repetitive work may spend up to 75% of their working day looking at a VDU screen and interacting with a computer

(Dainoff et al, 1981). Most of this research reviewed here has concentrated on computer-based rather than computer-supported work.

Hardware

There is a large research literature on both VDU workstation design (e.g. Grandjean, 1987) and input devices (e.g. Greenstein & Arnaut, 1987), though the former has been most strongly associated with symptom reports. VDU operators report a wide range of health complaints, from muscular aches and visual discomfort to emotional distress (Dainoff, 1982; Smith 1984). Recommendations about workstation layout, lighting levels, heat and noise have been made with the aim of reducing the levels of experienced discomfort (e.g. Health & Safety Executive, 1983; Mackay, 1980), though the physical properties of the VDU are viewed as the central cause of discomfort.

However, evidence for the relationship between the physical properties of the VDU and symptom reporting is controversial. No evidence for a direct link has been found (Dainoff, 1982; Oborne, 1985). Much of the evidence for symptoms is gathered from the verbal reports of VDU operators. As discussed in Chapters Two and Three, the reasons why people report symptoms are by no means simple, and such reports are unlikely to be a consequence of the physical environment (unless of course a direct link can be clearly observed). In more general terms it has been proposed that there are no direct links between objective ergonomic characteristics in computer work and symptom reporting, though indirect links may exist (Lim et al, 1989). Few studies of eye strain, for example, have attempted to relate subjective reports to performance, or to objective indicators of visual function. However, in such a study Dainoff et al (1981) found that VDU work had no effect on objective measures of visual function, even though users reported symptoms of eye strain. Also, physiological indices of excessive mental effort have found to be unrelated to VDU work (Tanaka et al, 1988).

In general, the evidence suggests that characteristics of work carried out at VDUs is the main cause of health complaints (Elias et al, 1983; Howarth & Istance, 1985; Sauter et al, 1981; Smith et al, 1983). Aspects of the organization and job and task demands which will be discussed in section 4.1.2. and 4.1.3. respectively, play an important part in determining these more general work characteristics. So too however will software, which is the second area of human factors research.

Software

Relatively little is known about the possible effects of software on the symptom reporting experienced by users. Turner and Karasek (1984) suggest two reasons for this ignorance. First, they propose that there is a relative lack of knowledge about the cognitive processes involved in interacting with software compared to the physiological processes thought to be involved in the effects of hardware on symptom reporting. Second, they suggest that the characteristics of the software are more difficult to measure than the physical characteristics of hardware. Two aspects of the software and the user interface will be discussed in turn; the dialogue structure, and more general system characteristics.

The term dialogue structure refers to the style in which the user is able to communicate with and receive information from the system. Shneiderman (1987) makes a distinction between three types of dialogue structure: menu selection, command language, and direct manipulation. Each of these has potential advantages and disadvantages depending partly on the task, and partly on the user's ability or knowledge. Menu selection, for example, where the user has a list of possible commands on display is useful for the novice, but may be frustrating for a more experienced user. In the case of a more experienced user, a command language style of dialogue structure may be more suitable. The extent to which a dialogue structure may affect levels of symptom reporting depends largely on the control, and the feelings of control, the user has over the task and the interface. Direct manipulation interfaces attempt to give the user a feeling of direct engagement with the system, and may reduce the effort required to accomplish goals (*Hutchins et al, 1985).*

Two more general characteristics of computer systems will be discussed here: response times, and feedback. Slow system response times have been found to reduce job satisfaction (Barber & Lucas, 1983) and increase mental demands (Johansson & Aronsson, 1984). As with dialogue structure type, the optimum response time will probably depend on the task (e.g. Kuhmann, 1989) and the user. Feedback is also an important characteristic of computer systems in relation to symptom reporting. Although there is no research on this topic, from general principles it would appear likely that the more knowledge a user has about the effects of their actions, the more control they will experience over the interaction.

Research on human factors suggests that, at least for computer-based working, the nature of the work may have effects on experienced symptoms. Although it is interface and software characteristics which will influence the nature of this work, very little human factors research bears on this issue.

4.1.2 The computer in the organization

A computer system does not exist alone, but in an organizational context. The way in which work is arranged, through organisational decisions, around the computer will have a number of implications. In this section some of the possible factors which result from the organizational context will be discussed. The common use of the word 'impact' when discussing the effects of computer systems on organizations and work environments (e.g. DeVaris, 1981; Blackler & Brown, 1985), implies that when computers and organizations are brought together, the result is a collision which sends shock waves through the organization. The effects of computer systems on organizations are complex and wide ranging (see Kling & Sacchi, 1982). The implications of the introduction and design of the system for an organization can be considered in a similar way as the effects of urban planning on people in a community (Kling, 1983).

There is little research which looks directly at the relationship between organizational features and symptom reporting in computer-supported work. However two broad areas can be identified, which operate in the short and the long term.

Introduction of computer systems

The way in which a computer is introduced into an organization is likely to have consequences for the levels of symptom reporting experienced when the system is used. Two main factors, user participation and training are most relevant. User participation in the design and or selection of the system should increase users' feelings of involvement and control, and may also produce a more usable system. There are a number of problems with such kinds of participation. For example a lack of technical knowledge on the part of the user, means that their level of participation is severely limited.

It is not uncommon for employees to receive very little or even no training at all in the system. Clearly a lack of knowledge about how to use the system will be a major source of demands during the introduction of the system, and probably for some time after that.

Longer-term effects

Longer-term organizational aspects of the introduction of computer systems which may have effects on symptom reporting include computer monitoring, communication and social interaction, user support and role change.

A worst case of these effects can be described. First, the user's output would be monitored by the computer (e.g., Irving et al, 1986). Second, the need to concentrate while interacting with the computer, combined perhaps with computer monitoring and open-plan offices, reduces social contact (e.g. Bjorn-Andersen, 1983; Cohen, 1984) and perhaps social support at work. These negative effects may however apply only to those engaged in less difficult and more simple jobs (Aronsson, 1989). The third aspect, closely related to training, is user support, where without informal sources of help and advice to hand, or continued training, the user may feel overwhelmed when they have a problem. Lastly, as a consequence of the introduction of the computer system, the user experiences a narrower role and less fulfilling role. An example can be found in the change from a typist to a word processor operator (Boddy & Buchanan, 1981).

Both the introduction and longer-term effects of the computer in the organization demonstrate that some of the potential factors associated with symptom reporting in computer-supported work are not associated directly with the technology, but are more to with the way in which the organization responds to the system, and incorporates the system into users' jobs.

4.1.3 Job and task demands

It is often assumed that the job and task demands associated with computer working are likely to result in increased levels of symptom reporting. Although computer working can lead to increased levels of symptom reporting, this is, as discussed earlier, often the result of job design rather than the computer itself. The introduction of computers into some jobs has been found to reduce levels of symptom reporting (e.g. Kalimo & Leppanen, 1985). The relationship then between the computer system, job and task demands, and symptom reporting is therefore a complicated one. In the short-term, the differences between the new demands and the old demands are likely to be the greatest source of symptom reporting. In the longer-term though, an increase in cognitive demands is most apparent.

First, is the increased involvement of working memory because of the mental model the user must develop of the system (e.g. Norman, 1986). Parts of this model must be retrieved in order to use the system, or to generate long sequences of commands. Second, attentional demands will be increased because of the requirement for the user to monitor the current state of the system and the effects their actions are having. This may make the user feel 'coupled' or 'yoked' to the computer system (Sauter et al, 1981). A flashing cursor or prompt may remind the user that the system is in an almost constant state of readiness for further input. The possibility of carrying out several tasks at the same time may also make demands on attention (Salvendy, 1982).

Third, a computer system has the potential to both increase or decrease decision making and planning opportunities. In the case of simple and repetitive computer-based work such as data entry for example, opportunities for control are severely limited. In some types of computer-supported work where the computer gives additional information, or increases the possibilities for management of existing information, the system may offer greatly increases planning opportunities (e.g. Hollnagel et al, 1986). However, it is also possible that in some situations the extra information a computer system offers increases discretion to such an extent that decision making becomes more difficult.

Other possible changes to job and task demands, apart from increased cognitive involvement, include pacing, and task structure. As already indicated, the user may feel coupled or yoked to the system, and therefore the response time will determine the pace at which tasks are performed. Task structure may also become more rigid. In order to search a database, for example, the user may have to go through a fixed set of procedures, where in a manual system, the user can determine their own search strategies. While there is almost no research which either compares the job and task demands of computer work with manual work, or assesses computer work alone, it is clear that computer systems can have a considerable effect on job and task demands which in turn may have an effect on levels of symptom reporting. On of the most important dimensions on which these effects can be viewed is controllability. Following the general relationship observed by Karasek (1979) discussed in Chapters Two and Three, where job and tasks demands are made less controllable, it is likely that levels of symptom reporting will increase.

4.1.4 Individual differences

There is almost no evidence about the possible relationships between individual differences, computer-supported work, and symptom reporting. It has been suggested however that cognitive style may play some role in determining the way in which a user interacts with a system (e.g. van de Veer et al, 1985; Robertson, 1985). In addition, there is some evidence that spatial abilities influence the speed of learning and ease of use of word processing systems (Sebrechts et al, 1984; Gomez et al, 1986).

4.1.5 Conclusions and summary

A wide range of jobs use computers. The distinction made earlier between computer-based and computer-supported work is crucial in determining the extent to which the factors discussed above contribute to symptom reporting. For more complex, higher status professional jobs, it appears as though these factors have little effect on symptom reports (e.g. Aronsson, 1989; Sainfort, 1990). This may in part be due to users in complex jobs spending a lower proportion of their time interacting with the computer, but it is equally, if not more likely to be a consequence of the role of tool which the computer comes to plays in more complex jobs. In less complex, computer-based jobs the computer is in no sense a tool which helps the user with their job and task goals: Operating the computer is in itself the whole job. The relevance of each of these factors will therefore vary from population to population.

Four areas of possible factors were discussed as follows: First, under human factors, hardware, software and workstation design were considered. Hardware design and particularly VDU design have been associated with higher symptom reporting, though it is unlikely to be as a direct result of the hardware properties. Second, organizational factors included the way in which computer systems were introduced, user participation and training. In the longer term, computer monitoring, effects on communication, user support, and role change, were considered to be relevant. Third, job and task demands were viewed mainly in terms of increased cognitive effort, in particular the use of working memory and attentional demands. The additional information which is often available with computer systems may aid decision making and planning but may also overwhelm the user. Rigid software may increase pacing and task structure. Little is known about individual differences, although differences in specific cognitive abilities, such as spatial skills may be important. As indicated earlier, not all of these factors will be assessed in this and subsequent studies. Those most suited to the methodologies used in the thesis and the theory will be used.

4.2 Method

This section describes the sample and procedure and questionnaire design.

4.2.1 Sample and procedure

In considering the aims of this study, and the conclusions drawn from the review of variables which may be important in the level of symptom reporting, it was decided that ideally the participants in the sample would have to meet at least two criteria. First, the work of the participants must meet the definition of computer-supported work given at the beginning of this chapter, which is office based work which involves the use of computers for specific tasks within a job. The second criterion involves the importance of job complexity and the role of the computer in the user's job in determining the quality and extent of symptom reporting in computer-supported work. In order to examine this possible effect, the sample will therefore have to contain more than one job grade, or level of job complexity, while at the same time using the same or similar computer systems.

As a result of a colleagues suggestion, a visit was made to a local General Practice which used a computer system. From discussion and observations it became clear that the first criterion had been met: The computer was being used for specific tasks within a job. It also became clear that the second criterion could possibly be met by this sample (depending on responses), as both receptionists and General Practitioners (GPs) used the system. Further details of the work done with these systems in General Practice appears in section 4.2.2. below.

Following this visit contact was made with the Primary Health Care Specialist Group of the British Computer Society. This group has several hundred members who have an interest in the use of computers in primary health care, and in particular in General Medical Practice. The aims of the research were described, and the committee agreed to participate by sending out copies of questionnaires to individuals on their mailing list. In return, it was agreed that feedback would be given to the participants by presenting the findings of the research at the annual conference of the group.

Two copies of the questionnaire with pre-paid return envelopes were sent out with a letter which explained that the study was concerned with the "impact of computers on well-being and work effectiveness", suggesting that ideally the participants should be frequent users of the computer system. This letter also requested that the recipient passed on either both copies, if the recipient was not a frequent computer user, or the additional copy if the recipient was a frequent computer user, to a suitable work colleague(s).

Approximately 640 people on the mailing list received packages containing the letter, questionnaires and the pre-paid return envelopes. Following one reminder, a total of 274 completed questionnaires were returned. The response rate however is difficult to calculate, as the number of eligible participants initially contacted is unknown for a number of reasons. First, it is not known how many recipients passed on both copies or the second copy of the questionnaire. Second, it is not known how many recipients were eligible in that they were computer users and worked in General Practice. In the reminder, recipients were asked to complete a form indicating whether or not they worked in a General Practice and used a computer. From the 441 returned and completed reminder forms, 161 or 37.5%, indicated that they either did not use a computer and/or did not work in general practice, and were therefore ineligible to take part in the study. If an assumption is made that the figure of 37.5% ineligibility is approximately correct for the whole sample, then 37.5% of the initial 640 were not eligible. This means that approximately 400 of the initial sample were eligible. An approximate response can be thus be calculated. If the additional copy was passed on by the eligible recipient to a suitable colleague then the response rate was 34%. If the additional copy was not passed on, the response rate was double this figure at 68%. The actual response rate is likely to be in between these two figures.

Within the sample of 274, 48% were GPs, 28% were receptionists, and the remainder were either GP trainees, practice managers, computer operators, or paramedical staff. The second criterion, that a range of jobs were present in the sample had been met by this pattern of response. 77% of the sample worked 40 hours or more per week in the practice, and the mean number of years spent working in the practice was 8.2 (SD = 7.6). The mean percentage of time at work spent using a computer, for the whole sample was 36% (SD = 28). Over twelve different makes of computer system software were used. The mean length of time the current system had been installed in the practices was 24.5 months (SD = 21.5). Within these practices, over 60% of GPs and 70% of employed staff used the system.

4.2.2 Questionnaire design

This section will describe the procedure used in the design of the questionnaire. Some of the design needs arose from the specific use of computers in General Practice, and some from the general aims of this study. Each of these will be discussed in turn. As indicated above, very little research has been conducted on the determinants of symptom-reporting in computer-suported work. There are therefore few scales or measures which can be taken from other studies for use here. In particular, there are no measures which tap the psychological, job, and task characteristics of computer working. The first stage in the development of the questionnaire then was to examine the kinds of work done on computers in General Practice.

The use of computer systems in General Practice

Computers have been used in General Practice for well over ten years, though their use is not widespread. In 1988 for example, approximately 10% of practices in the U.K. had a computer (Fitter & Garber, 1988). Although there are a number of different systems, most have a number of features in common. In general they are used for storing and retrieving information about patients, including medical histories, dates of treatments, prescriptions and recalls. Such information can be entered or retrieved during or outside consultations with the patient. In addition, most GP computer systems also include a word processor and facilities for ordering and printing prescriptions.

As mentioned above, a visit was made to a General Practice Surgery in order to discuss and make observations of computer use in General Practice. From this visit a number of requirements for the questionnaire became apparent: First, that as the computer was used for a wide range of activities, differences in the range and type of activities should be assessed; second, a separate section for those GPs who used the computer during consultations was necessary; third, some means of comparing the characteristics of working with the computer with the characteristics of similar activities undertaken manually was necessary; and fourth, that the indirect or secondary effects of using a computer on other areas of work be evaluated.

Measurement requirements arising from aims of study

Apart from the specific tailoring of the questionnaire to the work of the sample, a number of requirements arise from the general aims of the study. A measure of attitudes towards computers, and usability were included, as was a measure of dissatisfaction with the physical characteristics of various aspects of the computer system and the environment in which it was used.

It was decided that the questionnaire should assess symptom reports both while using the computer and more generally at work. While previous studies of computer usage and symptom reports have asked only about general symptoms at work, most of these studies examined computer-based rather than computer-supported work. For computer-based work, because of the intensity and duration of computer work symptom reports generally at work can be assumed to be connected with computer usage. For computer-supported work, reports of general symptoms at work are unlikely to be connected with computer usage in the same way.

4.2.3 Measures

Those measures which were developed in order to meet the requirements arising from contact with users in General Practices will be discussed first, followed by those arising from the general aims of the study. The means, standard deviations, and intercorrelations for these measures can be found at the end of this section in tables 4.1 and 4.2. Because of a lack of previous research, most of the measures used were developed for this study. Principal components factor analyses with varimax rotation were used to develop factor-based measures of the variables used in the study.

Activities using the computer

Three such factor-based measures of computer activities were used. Each item gave a description of the activity, and asked how much of the time using the computer was spent on each activity. The four-point response scale for these activities, and computing activities during the consultation, was scored from 1 (none/hardly any) to 4 (a great deal). The three measures were as follows:

1. Registration. This contained three items, checking registration details, registering new patients, and entering surgery lists.

2. Writing. This three-item scale was composed of using the word processor, producing letters or labels, and identifying patients for recall. The word processor is used almost exclusively for recalling patients, which accounts for the presence of the third item in this scale.

3. Repeat prescriptions. This scale was composed of two items: Ordering repeat prescriptions, and printing repeat prescriptions.

Characteristics of different work areas

The items used for assessing these characteristics were based on typical measures of job characteristics used elsewhere (e.g. Caplan et al, 1975; Hackman & Oldham, 1975). Three characteristics, workload, responsibility, and autonomy were measured in two work areas; processing information manually and processing information using the computer. Respondents were asked to consider the extent to which a statement (e.g. 'I have a lot of responsibility') accurately described their work in each area. The five-point response scale used two anchors, and the scoring ranged from 1 (hardly or not at all) to 5 (to a very great extent). Each of these characteristics was tapped in both work areas.

4. Workload. This was a three-item scale composed of the following items: I work very quickly; I work very hard; I have a great deal to do.

5. Responsibility. Three items were used in this scale which is a combination of items relating to responsibility and mental effort which may accompany such responsibility. The items were as follows: I have a lot of responsibility; I have to concentrate; I have to make careful decisions.

6. Autonomy. A two item scale was used: I repeat the same procedures; I can only do things one way. Both of these items were reverse scored.

Secondary effects of computer use on other areas of work

The perceived negative effects of having a computer in the practice on three other work areas, processing information manually, dealing with patients, and working directly with other members of staff was assessed. Respondents were asked the extent to which they agreed or disagreed with statements describing some of the possible secondary effects on other work areas of having a computer in the practice. Responses were scored on a five-point scale from 1 (strongly disagree) to 5 (strongly agree).

7. Secondary effects. This contained four items as follows: makes it more difficult; increases time pressure; makes it more stressful; increases workload.

Attitudes

Both feelings towards using the computer and interest were tapped in a four item scale containing statements about attitudes towards computers. Respondents were asked the extent to which they agreed or disagreed with the statements, on the same scale as the above measure.

8. Attitudes. The four items were: I enjoy using the computer; using the computer is interesting; I would rather do tasks manually than use the computer (reverse scored); I do not want to know any more about the computer (reverse scored).

Usability and benefits

A number of aspects of usability and perceived benefits were tapped in these measures. Respondents were asked to rate how much of the time a number of statements applied to the computer system they used. The response scale ranged from 1 (hardly ever/never) to 5 (most/all of the time).

9. Usability. Three items were used in this quite general measure of usability or ease of use: The commands and procedures are awkward to use (reverse scored); The documentation is helpful; It is not clear what the computer is doing (reverse scored).

10. Performance. A two item measure was used to tap the performance of the computer system. The two items used were the computer is reliable and the computer is quick to respond.

11. Planning benefit. The two benefit measures assessed the extent to which a computer was seen to facilitate either planning and decision-making or workload management. The planning benefit measure contained two items: The computer enables me to make better decisions, and, the computer helps me to plan my work more effectively.

12. Workload benefit. This also contained two items, both of which were reverse scored: The computer is responsible for delays in my work, and, the computer creates extra work.

<u>Dissatisfaction with physical characteristics</u>

These measures were adapted from others used in studies of the effects of work environment on the well-being of computer workers (Rafaeli & Sutton, 1986; Stellman et al, 1987). Respondents were asked the extent to which they were satisfied or dissatisfied with a number of aspects of the physical environment. The four point response scale ranged from 1 (very satisfied) to 4 (very dissatisfied).

13. Workstation dissatisfaction. Four items, computer furniture, lighting, heating, and layout of equipment were used.

14. Screen and keyboard dissatisfaction. This contained two items, which asked about the computer screen and the computer keyboard.

Symptoms

The list of symptoms used was taken from those used by Rafaeli & Sutton (1986), which may be particularly relevant for computer users. To this list were added a number of psychological symptoms in the form of descriptions of affective states.

Respondents were first asked if they ever experienced any of the symptoms when they were using the computer and second generally at work. A three point response scale was used and was scored as 1 (rarely/never), 2 (sometimes), and 3 (often).

15. Affect. This was a three item measure and was composed of three sets of adjectives: tenseness or nervousness; unease or anxiety; frustration or irritation.

16. Muscular aches. Two items describing symptoms were used for this measure: backaches or back pains; stiff neck.

17. Headaches and eye strain. Two items, eye irritation or strain and headaches were used in this measure.

Reliability of measures

Table 4.1 below shows the mean, standard deviation, and reliability (Cronbach's coefficient alpha) of each of the measures developed in this study.

Table 4.1. Means, standard deviations, and reliability estimates (coefficient alpha) of the measures developed in this study

Measure	Alpha	Mean	SD
Computer activities			
1(1). Registration	.62	1.67	.62
2(2). Writing	.65	1.86	.69
3(3). Repeat	.87	2.52	1.08
Manual characteristics			
4(4). Workload	.74	3.52	.92
5(5). Responsibility	.78	3.65	1.04
6(6). Autonomy	.38	2.92	.91
Computer characteristics			
4(7). Workload	.71	3.68	.89
5(8). Responsibility	.72	3.94	.85
6(9). Autonomy	.44	2.59	.94
Secondary effects			
7(10). Manual work	.76	2.84	.74
7(11). Patient work	.79	2.69	.74
7(12). Other staff	.84	2.81	.76
8(13). Attitudes	.71	4.32	.57
9(14). Usability	.64	3.94	.73
10(15). Performance	.55	4.31	.56
11(16). Planning benefits	.75	3.09	1.04
12(17). Workload Benefits	.61	3.41	.89
13(18). Workstation	.82	1.94	.51
14(19). Screen	.70	1.71	.47
Computer symptoms			
15(20). Affect	.63	1.45	.37
16(21). Muscular	.69	1.32	.48
17(22). Headache	.64	1.41	.50
Work symptoms			
15(23). Affect	.67	1.57	.42
16(24). Muscular	.52	1.25	.40
17(25). Headache	.47	1.31	.39

n ranged from 268 - 274

Variable numbers preceding those in parentheses refer to the numbers used above in the method section where each of these variables is described. Numbers in parentheses indicate the variable numbers used in table 4.3.

The alpha coefficient of reliability of some of these measures, in particular autonomy, performance, and muscular and affect work symptoms, falls below the figure usually considered to be adequate (see e.g. Cronbach, 1951). However, it was decided to include these measures in the following analyses as they were logically consistent. In addition, as the aims of the study were largely exploratory and no claims for the generalizability of the results would be made, it may in this context be important to include measures which although that may be unreliable may also be important.

Other measures

A number of other measures were also taken, not all of which were used in all the analyses presented in the results section. A number of questions were asked in order that the effects of some variables could be controlled for in some of the analyses. The number of workstations (a printer and a VDU) in the practice per user was calculated (mean = .39, SD = .22). In addition to the percentage of time at work spent using a computer, reported above in section 4.2.1, the number of hours spent using a computer per week was also calculated (mean = 12.45, SD = 9.34).

An additional computer work characteristic variable, called computer variety, was calculated by counting the number of responses which indicated that the respondent spent a small amount of time, or more time, on each activity within the three computer activity scales (registration, writing and repeat). The mean score on the eight activity items contained in these three scales was 4.43 (SD = 1.85).

An additional symptom variable, which describes the relative level of symptom reporting between computer work and work in general was calculated by subtracting the total intensity of symptoms reported as experienced at work from the total intensity of symptoms reported as experienced while using the computer. The mean value of this variable (relative symptoms) was .01 (SD = .29). Of the whole sample, 39% reported that they experienced more intense symptoms while using the computer (a positive score on relative symptoms), 29% reported no difference (a score of zero on relative symptoms), and 39% reported that they experienced relatively more intense symptoms at work than they did while using the computer.

4.3 Results

The main aim of this study is to investigate the psychological determinants of symptom reporting in computer-supported work. In general, the aim will be to examine relationships between symptom and secondary effect measures, in relation to all other measures, which will be referred to generally as computer work variables. After reporting correlations between the measures developed in this study (section 4.3.1), two questions which address the aims of this study will be answered, these are:

1. What are the gross associations between the symptom and secondary effect variables and the computer work variables? Gross in this context refers to associations which are calculated before controlling for the effects of other variables. (See section 4.3.2.)

2. What are the net effects of the computer work variables on the symptom and secondary effect variables? Here, net means controlling for a number of other variables (such as age and sex) which are in this study psychologically unimportant, but may be associated with symptom reporting.

This question can be further refined by asking: (a) What are the strengths of the associations between the symptoms and secondary effects and the computer work variables?; and (b) What proportion of the variance in each of the symptom and secondary effect variables can be accounted for by each of the computer work variables? (See section 4.3.3.)

4.3.1 Correlations

Table 4.2 (a, b, and c) below shows the Pearson correlation coefficients between the measures developed in this study.

Table 4.2 (a) Intercorrelations between measures developed in the study

Variable	1	2	3	4	5	6	7	8	9
Computer activities									
1 Regist	-								
2 Writing	15	-							
3 Repeat	36		-						
Man chars									
4 Workload				-					
5 Responsib				52	-				
6 Autonomy			-13		-13	-			
Comp chars									
7 Workload	34	13	19	30	16	-15	-		
8 Responsib	-22	16	16	22	58		43	-	
9 Autonomy	-19		-17	-11	-24	54	-23	-19	-
Second effs									
10 Manual									
11 Patient							-21		
12 Staff			-15				-13		
13 Attitude		22					17	17	15
14 Usability	14	21							
15 Perform									
16 Plan Ben		18							20
17 Work Ben	15		18						
18 Workstn									
19 Screen									
Computer									
20 Affect									
21 Muscular					14			13	
22 Headache	31		25			17	21		
Work									
23 Affect									
24 Muscular									
25 Headache	20		21					13	

Coefficients where $p > .05$ (two-tailed) have been omitted from the table as have decimal points.

Description of the results presented in table 4.2 (a, b, and c) will proceed by considering significant associations with each of the variables or groups of variables presented in the left hand column of the table. Description of the associations between the computer work variables and secondary effects (variables 10-12) and computer symptoms (20-22), will take place mainly in section 4.3.2. In describing the relationships between these variables from the correlational analyses in this section and in section 4.3.2 the concern will be to examine general patterns of relationships rather than only the strengths of relationships.

From table 4.2 (a) above it can be seen that there were some weak but consistent relationships between the ratings of characteristics of working with computers (7-9) and computing activities (variables 1-3). In particular, more time spent on registration activities was associated with higher ratings of workload, and lower ratings of responsibility and autonomy. Stronger associations were found however between computer work characteristics and manual work characteristics (4-6). While workload and responsibility were positively correlated between the two work areas, autonomy in one area of work was weakly but negatively correlated with both workload and responsibility in the other. Using an example to describe this relationship, higher ratings of autonomy in, say, processing information using the computer were associated with lower ratings of workload and responsibility in processing information manually.

Table 4.2 (continued) (b). Intercorrelations between measures developed in the study

Variable	10	11	12	13	14	15	16	17	18
Second effs									
10 Manual	-								
11 Patient	59	-							
12 Staff	53	66	-						
13 Attitude		-20	-15	-					
14 Usability	-24	-26	-30	20	-				
15 Perform		-14	-16	29	31	-			
16 Plan Ben		-20		31	15	22	-		
17 Work Ben	-42	-53	-48	17	34	21		-	
18 Workstn	15			-13	-15	-17	-13		-
19 Screen				-21	-25	-16			47
Computer									
20 Affect	34	25	25	-23	-27	-24		-25	24
21 Muscular			18						
22 Headache				-24					
Work									
23 Affect	15	13	23		-14	-13			18
24 Muscular			17						
25 Headache									

Table 4.2 (continued) (c). Intercorrelations between measures developed in the study

Variable	19	20	21	22	23	24	25
19 Screen	-						
Computer							
20 Affect	17	-					
21 Muscular		16	-				
22 Headache		23	39	-			
Work							
23 Affect		48			-		
24 Muscular			63	15		-	
25 Headache		13	21	58	16	23	-

Coefficients where p > .05 (two-tailed) have been omitted from the table, as have decimal points.

Negative relationships between autonomy and both workload and responsibility were also found within each work area. Strong associations were found between workload and responsibility within each work area.

Few consistent relationships between the measure of computer attitudes (13) and other computer work variables are apparent when we only consider those correlations coefficients given in row 13. See below for significant associations between attitudes and other variables. Attitudes towards computers within this sample were as a whole were very positive. As reported in table 4.1, the mean score for the whole sample on the attitude scale is 4.32 maximum score is 5. A similar pattern, or rather lack of pattern was found in relationships between usability (14) and system performance (15), with the exception of positive associations between usability and both registration and repeat prescription activity. However, from table 4.2 (b) it can be seen that positive relationships were found between attitudes and both usability and performance.

The benefits of using a computer for the facilitation of planning (16) were positively associated with ratings of writing activity (2), responsibility (8), and autonomy (9) in computer working. Workload reduction benefits was weakly but positively associated with registration and repeat prescription activity. Table 4.2 (b) shows that benefits of using a computer for both planning and workload reduction (17) were positively associated with ratings of usability (14) and system performance (15).

Dissatisfaction with the workstation (18) and the computer screen (19) was not associated with most of the variables in table 4.2 (a). However, table 4.2 (b) shows consistent negative relationships between ergonomic dissatisfaction and attitude (13), usability (14), performance (15), and weaker but still negative relationships with planning benefits (16) and workload reduction benefits (17).

As stated above, a description of the relationship between the symptom and secondary effect and computer work variables will take place in section 4.3.2. However, relationships amongst the symptom and secondary effect variables will be discussed here. Table 4.2 (b) reveals that there are positive associations between affective symptoms reported while using the computer (20) and the three measures of the secondary effects of having a computer in the practice (10, 11, 12). This same pattern can be found for affective symptoms which are reported as experienced generally at work (23).

Table 4.2 (c) shows a number of relationships between the six measures of symptoms (20 - 25). Moderate associations were found between the same symptom types in each work area. For example, a coefficients of $r = .48$ was found between affective symptoms reported as experienced generally at work (23) and affective symptoms reported as experienced while using the computer (20).

4.3.2 Gross effects

Some of the correlations reported here have already been reported in Table 4.2 above. They are repeated in this table to enable comparisons between each computer work variable and each symptom and secondary effect variable to be made more easily.

Table 4.3 Correlations between the symptom and secondary effect and computer work variables: Gross effects

		Computer Symptoms			Secondary Effects		
	Affect	Musc	Head	Man.	Pat.	Staff	Relative Symptoms
Computer Activities							
Registration			.31				.19
Writing							
Repeat			.22			-.15	
Computer chars							
Workload			.17		-.21	-.14	
Responsibility		.13	.21				
Autonomy							-.19
Attitude	-.23		-.24		-.20	-.15	-.28
Usability	-.27			-.24	-.27	-.31	
Performance	-.24				-.14	-.16	
Planning							
Bens					-.20		
Work Bens	-.25			-.42	-.53	-.48	
Work station	.24			.15			.14
Screen	.17						.13
Computer Variety			.14				

Coefficients where p > .05 have been omitted from the table.

First, the associations between each computer work variable in turn and all the symptom and secondary effect variables considered together will be described. Next, those variables which are associated with each symptom and secondary effect variable will be described.

Few associations were found between the three computer activities and the symptom and secondary effect variables. However, registration activity was positively associated with headaches and relative symptoms, while repeat prescription activity was associated positively with headaches, and negatively with secondary effects of working with other members of staff. This latter relationship suggests that more frequent repeat prescription activity was associated with lower ratings of negative secondary effects of having a computer in the practice on working with other members of staff.

For computer characteristics, workload and responsibility were positively associated with headaches. Workload was negatively associated with secondary effects in working with patients and other members of staff. Autonomy was negatively related to the level of relative symptoms. Attitude was negatively associated with all symptom and secondary effect variables with the exception of muscular aches and secondary effects on processing information manually. The strongest associations were found with affective symptoms, headaches, and relative symptoms.

A number of negative associations were found between usability, system performance, and the symptom and secondary effect variables. Lower ratings of both usability and system performance were associated with affective symptoms and secondary effects on working with patients and other members of staff. Lower ratings of usability alone were associated with secondary effects on processing information manually.

The measure of the perceived benefits of having a computer in the practice for the facilitation of work planning was negatively associated with secondary effects on working with patients. Workload benefit was negatively associated with headaches, and more strongly with all three secondary effect measures.

Dissatisfaction with the both the workstation and computer screen was positively associated with both affective symptoms and relative symptoms.

Dissatisfaction with the workstation alone was positively associated with secondary effects on processing information manually. Only one association with computer variety and any symptom and secondary effect variable was found: Variety was positively associated with headaches.

Each symptom and secondary effect variable will now be considered in turn. A total of six computer work variables were associated with affective symptoms. Considering the strongest relationships, attitude, usability, system performance, and workload benefits were negatively associated, and work station dissatisfaction positively associated with affective symptoms. Only one very weak relationship was found with muscular aches; a positive association with computer work responsibility. Six computer work variables were associated with the variable which tapped headaches (and eye strain). Two computing activities, and three computer work characteristics (including computer variety) were positively associated with headaches. Headaches were also negatively associated with attitude.

Usability and particularly workload benefits were negatively associated with secondary (negative) effects of having a computer in the practice on processing information manually. Dissatisfaction with the workstation was positively associated with this variable.

Six associations, all of which were negative, were found between the computer work variables and secondary effects on working with patients. These were computer workload, attitude, usability and system performance, and both measures of benefit. Repeat prescription activity and computer workload were negatively associated with secondary effects on working with other members of staff, as was computer workload. Other measures associated with this secondary effect were, like the other two secondary effect measures, attitude, usability and system performance, and benefits for workload. Five variables were found to be associated with relative symptoms. Registration activity, workstation and screen dissatisfaction were positively associated with relative symptoms, while autonomy and attitude were negatively associated.

4.3.3 Net effects

In this section the net effects of the computer work variables on the seven symptom and secondary effect variables are described. Before this however, a brief introduction to multiple regression as a data analysis technique will be given, followed by description of the specific procedure used in these analyses.

Give the central aim of the study, to look at the relationship between a large number of computer work variables (e.g. computer activity, workload, computer usability) and a symptom or secondary effect variable, symptom reports, multiple regression is the ideal data analysis technique, as it can be used to simultaneously predict a dependent variable from a number of computer work variables. The word simultaneous in this context means that the effects of a single independent variable, or groups of independent variables on the dependent variable, and on each other, are taken into account at the same time. This enables the proportion of variance accounted for by combinations of independent variables to be calculated. Analysis of variance/analysis of covariance is actually a special case of multiple regression/correlation (Cohen & Cohen, 1975).

Procedure for analyses and variables in the control block

Separate multiple regression equations for the effects of each computer work variable on each symptom and secondary effect variable after controlling for a number of other variables were used for two purposes. First, to indicate the probable strength of associations between the computer work and symptom and secondary effect variable, and second, to examine the proportion of variance in the symptom and secondary effect variables accounted for by the computer work variables. Each of these will be discussed in turn. The following description refers to the figures in tables 4.4 and 4.5. In these tables, the column heading B represents beta, the standardized regression coefficient. It is calculated using variables expressed in standardized form, which enables comparisons to be more easily made between the regression coefficients of independent variables measured in different units. The regression coefficient is the slope of the straight line given by the regression equation, and thus indicates the extent to which an increase in an independent variable would increase or decrease the level of the dependent variable.

The proportion of variance accounted for in the dependent variable by each independent variable is indicated by the figures in the column heading R^2. R^2 is the squared multiple correlation between all the independent variables in the equation and the dependent variable. The R^2 figure for the control block in tables 4.4 and 4.5 is the adjusted R^2, which takes account of the number of variables in the regression equation. The R^2 figures following the control block in each dependent variable column is the change in total R^2 as a result of adding each independent variable into the equation. In other words, the change in R^2 shows the proportion of variance in the dependent variable accounted for by each independent variable after controlling for the effects of all the variables in the control block. From table 4.4, under the column heading 'Affect', the adjusted R^2 for the control block is .23, indicating that the control block accounts for 23% of the variance in affective symptoms reported whilst using the computer.

The variables used in the control block were as follows: Sex (dummy coded), age, job title as GP or staff (dummy coded), computer system in use (dummy coded), characteristics of processing information manually (workload, responsibility, autonomy), symptoms reported as experienced generally at work (affect, muscular, headache), the length of time the current computer system had been installed, the number of workstations per user in the practice, the percentage of time spent at work using a computer, and number of hours per week spent using a computer. The two latter variables were found to be unrelated in regression analyses with the other variables included in the following analyses to any of the symptom and secondary effect variables, they were however included in the control block of variables as they may have interactive effects with some of these control variables.

These control variables were chosen as while they are likely to be empirically important determinants of symptom reporting, they are unimportant in the context of this study, where the more psychological determinants are of interest. Of course, in other studies, for example one which examined the effects of say age or system type on symptom reporting in computer-supported work, these variables would be important.

Net effects on symptoms

Table 4.4 below shows the net effects of the each computer work variable on symptom reports. The results will be described by considering each symptom and secondary effect variable in turn.

Table 4.4 Results of multiple regressions showing the net effects of computer work variables on symptom reports

	Computer symptoms						Relative Symptoms	
	Affect		Musc		Head			
	B	R^2	B	R^2	B	R^2	B	R^2
Control Block	-	.23***	-	.51***	-	.40***	-	.23***
Computer Activities								
Registration					.11	.01		
Writing								
Repeat								
Computer chars								
Workload	-.13	.01					-.14	.01
Responsibility								
Autonomy	-.18	.02*					-.18	.02*
Attitude	-.22	.04***			-.17	.02**	-.23	.04***
Usability	-.22	.04***			-.15	.02*	-.22	.04***
Performance	-.14	.02*			-.11	.01	-.14	.02*
Planning								
Benefits	-.15	.02*					-.15	.02*
Work Ben	-.25	.05***	-.08	.01	-.19	.03**	-.25	.05***
Work station	.13	.01*	.09	.01	.11	.01*	.13	.01*
Screen	.18	.03**			.12	.01*	.18	.03**
Computer								
Variety								

Column headings: B represents Beta the regression coefficient (standardized). R^2 represents the change in R^2, the squared multiple correlation, as a result of adding each variable to a separate regression equation. The R^2 reported for each block of variables entered is the adjusted R^2 which takes account of the number of independent variables in the equation.

The symbols in the table are used as follows:

* $p < .05$ ** $p < .01$ *** $p < .001$

Where the change in R^2 was less than .01 the beta weight or the change in R^2 have not been printed.

From table 4.4, it can be seen that 23% of the variance in affective symptoms was accounted for by variables in the control block. Eight computer work variables accounted for variance in affective symptoms: Considering those which explained most variance, attitude and usability each accounted for 4%, and workload benefits for 5%. Dissatisfaction with the screen accounted for 3%, autonomy, system performance, and planning benefits for 2%, and work station dissatisfaction for 1%. For muscular symptoms, a large proportion of the variance, 51%, was accounted for by variables in the control block. No other variables explained significant proportions of variance. 40% of the variance in headaches (and eye strain) was accounted for by the control block. Attitude, usability and workload benefits accounted for 2%, 2% and 3% of the variance respectively.

Exactly the same pattern of relationships between the computer work variables with affective symptoms, described above, was found for relative symptoms. There were some minor differences which are not apparent in the tables because of rounding.

<u>Net effects on the perception of secondary effects</u>

Table 4.5 below shows the net effects of each computer work variable on the measures of perceptions of secondary effects of having a computer in the practice on other work areas. In the same way as the description above, each variable will be discussed in turn.

Table 4.5 Results of multiple regressions showing the net effects of computer work variables on the perception of secondary effects

	Secondary Effects					
	Manual Work		Patient Work		Staff Work	
	B	R^2	B	R^2	B	R^2
Control Block	-	.02	-	.12**	-	.09*
Computer Activities						
Registration						
Writing						
Repeat						
Computer chars						
Workload			-.19	.02*	-.12	.01
Responsibility			-.10	.01	-.15	.01
Autonomy						
Attitude	-.16	.02*	-.24	.05***	-.17	.02*
Usability	-.16	.02*	-.11	.01	-.22	.04**
Performance						
Planning						
Benefits			-.25	.05***	-.14	.02*
Work Benefits	-.40	.12***	-.45	.15***	-.43	.14***
Workstation			.13	.01		
Screen	.09	.01	.10	.01	.13	.01
Computer						
Variety						

Column headings: B represents Beta, the regression coefficient (standardized). R^2 represents the change in R^2, the squared multiple correlation, as a result of adding each variable to a separate regression equation. The R^2 reported for each block of variables entered is the adjusted R^2 which takes account of the number of independent variables in the equation.

The symbols in the table are used as follows:

* $p < .05$ ** $p < .01$ *** $p < .001$

Where the change in R^2 was less than .01 the beta weight or the change in R^2 have not been printed.

The control block did not account for a significant amount of the variance in the measure of secondary effects on manual work. Attitude and usability each explained 2% of the variance, while workload benefits accounted for 12%. 12% of the variance was accounted for by the control block in the measure of secondary effects on working with patients. Computer workload explained an additional 2% of the variance, attitude and usability each 5%, and workload benefits 15%. For secondary effects on working with staff, the control block explained 9% of the variance. Attitude and planning benefits each accounted for 2%, usability for 4%, and workload benefits for 14%.

4.4 Discussion

The aims of this study were to examine some of the psychological determinants of symptom reporting in computer-supported work. This discussion is divided into four sections, the first three of which are based on the more specific questions addressed in the results section. The first three sections then correspond with the three results sub-sections (4.3.1 - 4.3.3). The fourth section is a general discussion of the results.

4.4.1 Correlations between measures

As stated in 4.3.2 the purpose of these correlational analyses reported in 4.3.2 and 4.3.3 was, given the exploratory nature of this study, to examine general patterns of relationships between variables. The consistent relationships found between the characteristics of computer working and computing activities suggest that the experienced characteristics of computer working depend on how the system is used. The finding that more registration activity is associated with higher workload, but lower responsibility and autonomy, accurately reflects the repetitive nature of this type of computer work, where often large quantities of data are entered. The ability of these measures to reflect the activities undertaken in computer work is also apparent if the characteristics associated with repeat prescriptions are considered. The relationships between activity and characteristics are the same as those found with registration activity, except that responsibility is higher with repeat prescription activity. Given the significance of prescriptions in the work of a GP surgery, this is in many ways unsurprising, but it indicates that computer work can have a large range of characteristics which are dependent more on the activities undertaken in that work than the characteristics of the system itself. Indeed no relationships were found between usability and system performance, and computer characteristics.

The relationships between computer characteristics and the characteristics of processing information manually were quite consistent. The positive relationships between the two work areas for workload and responsibility suggests that workload and responsibility remain undifferentiated between these work areas: If workload and responsibility are, say, at high levels, they remain so however one is processing information. The weak negative association between autonomy in one area of work and workload and responsibility in the other may indicates that, for example, higher autonomy in computer working is associated with lower workload and responsibility in manual information processing. However, the same pattern of relationships exists within each area of work, so is likely to reflect a more general relationship in these jobs between higher levels of autonomy and lower levels of workload and responsibility.

Attitude was strongly associated with a number of other computer work variables. In particular, usability, system performance, planning and workload benefits were positively associated with attitude, and workstation and screen dissatisfaction were negatively associated.

It is possible that all these measures may to some extent be tapping the same underlying orientation towards the computer. For example, those who have positive attitudes also see the computer as more usable, more beneficial, and are less dissatisfied with its ergonomic characteristics. It is of course not possible to examine the direction of the relationships between these variables, but in previous studies, it is likely that attitudes towards computers generally become more positive with more experience of using computers. However, no known studies have examined changes in perceptions of usability or system performance, or perceptions of benefit over time. It is likely that complex relationships exist between, say, usability and attitudes. Each may, in differing circumstances, and at differing stages of usage, be mutually influential.

Usability and system performance were also associated positively with perceived benefits and negatively with ergonomic dissatisfaction, but were not associated with any other computer work variables. This suggests some underlying orientation towards the computer. However, the relationships between usability and particular computer activities suggests that perceptions of usability may depend also on what activities are undertaken with the computer.

The associations between planning and workload reduction benefits and particular activities using the computer suggests that here again it is the particular use to which a computer is put, rather than its use in general which will influence perceptions of benefit. An underlying orientation is indicated by the relationships between benefits and both usability/system performance ergonomic dissatisfaction.

The high intercorrelations between the same symptom types reported as experienced while using the computer and generally at work means that in responding to the symptom checklists individuals tended to report the same type, and the same level of symptoms whether or not they were using the computer. This suggests that symptoms were, in general, not attributed by the respondents to the use of the computer.

The patterns of correlations between variables suggests that measures such as computer work characteristics, and ratings of usability, are associated with the degree to which particular activities are undertaken in using the computer. The day to day experience of use is possibly one of the influences on more general perceptions and attitudes. This contrasts with the possibility that a number of the relationships between, for example, attitudes, usability, and perceptions of benefit reflect an underlying positive or negative orientation towards the computer.

In general, the interrelationships between the computer work variables suggests that different features of computer working and perceptions of the computer were being tapped by these measures, and that underlying orientations towards the computer were apparent.

4.4.2 Gross effects

This section discusses the associations between symptom and secondary effect and computer work variables before the effects of other variables are controlled. Considering the gross effects first allows the effects of the controlling for other variables in the later analysis to be observed. First, associations with symptom measures, and then associations with secondary effects will be discussed.

Particular computing activities and computer work characteristics, and variety were only associated with headaches and relative symptoms, whereas usability, work benefits and ergonomic dissatisfaction were only associated with affective symptoms. This pattern suggests that for this sample it is what was done while working with a computer which determines more physical symptoms, whereas aspects of usage which shape and are shaped by affective experience and feelings during use (e.g. benefits, usability, dissatisfaction) are connected with affective symptoms. It is perhaps surprising that no gross associations between ergonomic dissatisfaction and headaches were found.

With the exception of responsibility, no associations were found with muscular symptoms. The measure of relative symptoms had associations with both computer activities and characteristics, attitude, and ergonomic dissatisfaction. This measure taps those symptoms reported as experienced when using the computer which are over and above the symptom reports reported as experienced generally at work. In this sense, this measure is a better reflection of symptoms that are attributed by the respondents to computer use, which may explain the broader base of associations.

Turning to secondary effects, which are the extent to which having a computer in the practice increases the difficulty of work in other areas, a slightly different pattern emerges for processing information manually than the other secondary effects. Manual information processing is seen to be made more difficult by low usability, low work benefits, and dissatisfaction with the workstation. Informal reports suggest that difficulties can often arise when manual and computer information processing systems are used in parallel, or work in contradictory ways. The usability of a computer system may well be judged by the extent to which it is seen to fit in and support existing work patterns. Work station dissatisfaction can result from cramped conditions in which computers are used. Often, computers are placed in rooms without any additional furniture or space for additional furniture, so reducing much of the desk space used for more traditional manual information processing.

The moderately strong relationships between the measure of work benefits and secondary effects on manual *information processing* ($r = .42$), *working* with patients ($r = .53$), and working with other members of staff ($r = .48$), is partly the result of a number of conceptually overlapping items in these measures. In particular one item in the secondary effects measures asks if having a computer in the practice increases workload. Despite this very direct overlap, it is likely that in a more general sense, perceptions of whether or not a computer helps to reduce workload will depend partly on the effects of having a computer in the practice on all areas of work. The point remains that the benefits of using a computer in any work are likely to be weighed up in the context of the whole job rather than the part of the job which is directly performed through the use of a computer.

The slightly different pattern for secondary effects on working with patients and working with staff is the involvement of computer activity and characteristic variables. Here, higher levels of repeat prescriptions and workload were associated with lower levels of these secondary effects, indicating perhaps more positive attitudes with increasing use. Other associations were similar to those found with secondary effects on manual information processing.

These gross effects indicate rather different patterns of relationships depending on which symptom and secondary effect variable is considered. Clear differences between symptom types, with the exception of muscular aches, were found. In particular, affective symptoms were found to be unrelated to computing activities and characteristics, but strongly associated with usability, benefits, and ergonomic dissatisfaction, while the reverse pattern of relationships was found for headaches. In addition, the gross effects on secondary effects gave support for the influence of an underlying general orientation towards the computer. However, some quite specific relationships were found for secondary effects on processing information manually, which suggests that a particular orientation towards the computer may be less underlying or general than the results for other secondary effects suggest.

4.4.3 Net effects

These analyses were performed to assess the unique contribution made by each of the computer work variables to the symptom and secondary effect variables after controlling for the effects of a number of other variables. First the symptom measures and then the secondary effect measures will be discussed. The proportion of variance in the measures of symptoms accounted for by the control variables ranged from 23% - 51%. No computer work variable accounted for more than an additional 5% of the variance in any measure of symptoms. These control variables were not particularly theoretically important in the context of this study, but clearly had strong associations with the symptom and secondary effect variables. In particular, it is likely that symptoms reported as occurring generally at work were exerting a strong influence on symptoms reported while using the computer. The correlation coefficients between symptom types in the two work areas were found to be .48, .63, and .58 for affective, muscular, and headache symptoms respectively. Also, associations were found between ratings of job characteristics in each area: Correlations of .30, .58, and .54 were found between ratings of workload, responsibility and autonomy respectively. These findings taken together suggest that for this sample the experience of symptoms and the perceptions of job characteristics were similar in different work areas.

Easily distinguishable patterns of relationships for different symptoms discussed in the above section do not appear in the results of these analyses. However, attitudinal variables still have a larger impact on affective symptoms than do computing activities and characteristics. In addition, 40% of the variance in headache symptoms is accounted for by the control variables, which makes it less likely that these the computer work variables could be strongly related to headaches. The almost identical pattern of relationships between the computer work variables and symptom measures for headaches and relative symptoms suggests that affective symptoms are most clearly associated with symptoms which reflect aspects of computer use, over and above those symptoms experienced more generally at work.

Considering now the effects of computer work variables, no net effects of computing activities and characteristics, with the exception of autonomy were found: Controlling for other variables removes the effects of these variables. However, attitude, usability and work benefits remained influential, each accounting for most variance in symptom reports when all the computer work variables are considered together. While the percentage of variance involved is quite small, given the number of other variables whose effects were controlled for, these small figures are unsurprising.

The proportion of variance accounted for by the control block in measures of secondary effects was considerably less than for symptom measures. In the case of processing information manually it was statistically insignificant, while for patient work the percentage of variance accounted for was 12% and for staff work the figure was 9%. Control variables therefore seem to have little association with secondary effects, however, this is to be expected as the control variables were selected mainly on the basis of their possible effects on symptom measures, rather than these measures. The pattern of net effects on these variables is broadly similar to the pattern for gross effects.

Compared to symptom measures, attitude, usability (to a lesser degree), planning and work benefits also accounted for most of the variance in these measures of secondary effects. Workload remained negatively associated with secondary effects in patient work. The analyses of the net effects reveal a rather different pattern of relationships for symptoms, but not for secondary effects. The proportion of variance in symptom measures accounted for by the control variables was, as anticipated, moderate to high. Given the number of variables controlled for, the additional variance accounted for uniquely by a number of these computer work variables suggests that they are robustly associated with symptom reporting and perceptions of secondary effects.

4.4.4 General discussion: Determinants of symptom reporting

The picture that emerges from the above discussion is that lower computer autonomy, less positive attitude, lower perceptions of usability and system performance, lower perception of benefits, and higher levels of ergonomic dissatisfaction are associated with, and account for small amounts of variance in symptom reports, particularly affective symptoms and headaches, after controlling for a range of other variables.

Secondary effects are useful as a variable for confirming what is perhaps already known, but may not be particularly important as a dependent variable in computer-supported work. They do however serve as a reminder of the importance of considering not only the direct effects of using a computer on the experience of working with the computer, but also the indirect, secondary effects which in computer-supported work may be very significant. The high associations between secondary effects and perceptions of benefit for workload reduction and work planning indicate that these may be part of the same phenomenon: That unless the computer is seen to be useful in the general context of work, negative secondary effects will be more strongly experienced.

For those symptoms most associated with the computer work variables (affective, headaches, and relative) 23%, 40%, and 23% respectively of the variance was accounted for by the control variables. The maximum amount of variance any one of these variables uniquely accounted for was only 5%. These findings make it clear that the determinants of symptoms reporting in computer-supported work are often unconnected with the computer system itself, are often not particularly psychological, and where they are more psychological, account for little of the variance. The intercorrelations between symptom measures across different work areas suggests that a phenomena such as negative affectivity, or chronic symptom reporting (discussed in Chapter Three) may explain this consistency of affect and symptom reports.

These findings reflect the sheer number of variables, and the complexity of the relationships between variables discussed in the review of previous research at the beginning of this chapter. The lack of previous research symptom reporting and computer-supported work in this area is partly the result of approaching what appears as a straightforward practical issue in an oversimplistic way.

4.4.5 General discussion: Methodological issues

There are a number of general methodological problems and shortcomings in all cross-sectional research. One of the most acute of these is the difficulty of establishing any causality in the relationships between variables. An example from this study is the possibility of general orientation towards the computer suggested by a number of the findings. Untangling the relationships involved, for example, between perceptions of usability, workload management benefits, and symptoms would not be possible in this kind of research. On the other hand, such designs may be useful for suggesting broad patterns of relationships between variables, as illustrated in this study.

However, rather than discuss more of these general problems in cross-sectional research, the focus will be on those issues which are relevant for the study of symptom reporting in computer-supported work. One of the major difficulties is the arbitrary nature of many of the variables in this type of research, and the constraints placed on other forms of measurement. For example, it is quite clear that simply using a computer at work is not a variable, whereas many studies make using versus not using a computer the basis for the creation of groups. The activities undertaken by those using computers are diverse, and take place in the context of a whole job. To be a computer user, or a non-computer user does not necessarily imply or impose any particular conditions. Another difficulty with these variables is that although we may know that particular variables, say usability and affective symptoms are related, we do not know how they are related. We do not know what it is about perceptions of low usability which lead to higher levels of symptom reporting, and if these variables are associated on a day-to-day, hour-to-hour basis.

The methodological difficulties surrounding cross-sectional designs seem to be particularly acute when the phenomena under study are relatively subtle. In computer-supported work the symptoms reported, at least in this sample, are not particularly severe, and are therefore more difficult to examine with such a methodology.

4.5 Conclusion

While the methodology has various shortcomings, this study has shown that a number of variables are related to symptom reporting, and therefore these variables should be used, where suitable and along with others, in future studies. Other methodologies are more likely to yield substantive findings about the processes which produce symptom reporting. The predominance of affective symptoms in relation to computer work variables suggests that the focus should perhaps be this type of symptoms, rather than using general non-specific symptom measures. The value of using differentiated measures of symptoms was demonstrated.

In common with other areas of inquiry in stress research, the specific topic or focus of inquiry is often overshadowed by the number of weight of other influences on symptom reporting which are outside and irrelevant to the specific focus. If a specific topic is to be examined, the influence between variables and the processes of relationships rather than the facts of association need to be explored. In cross-sectional research, such an exploration is difficult to achieve.

Most importantly, the context of computer work must be considered and taken into account. If there are any effects of using a computer, these can only be assessed in the context of, and relative to other work activities.

CHAPTER FIVE

A WORK SESSION DIARY STUDY OF WORK AND COMPUTER HASSLES, WORKLOAD, AFFECT, AND SYMPTOMS

5.0 Introduction and aims

The previous study used a traditional cross-sectional design, typical of those used in most stress research, to examine the determinants of symptom reporting and perceptions of secondary negative effects of the computer system, in a sample engaged in computer-supported work. Two general kinds of information emerged: (1) findings about the patterns of relationships between these potential determinants, and (2) the methodological and theoretical limitations of this approach. The results suggested a quite consistent pattern of relationships between attitudinal variables and dependent variables, indicating the possible existence of a general negative orientation towards the computer, similar perhaps to negative affectivity. In addition between 23% - 51% of the variance in levels of symptom reports was accounted for by a number of variables which were unrelated to psychological aspects of computer working, and more to general determinants of symptom reporting. The methodological and theoretical limitations of this approach were noted, in terms of the inherent difficulty in making causal interpretations in cross-sectional designs, and in terms of the difficulty in making general interpretations of these results in psychological context of computer-supported work.

In an attempt to overcome some of these limitations, this study uses a different methodology, incorporating diary measures of hassles and affect. These have recently begun to be used more widely in stress research (e.g. Bolger et al, 1989; Caspi et al, 1987; DeLongis et al, 1988; Eckenrode, 1984), and provide results which can be interpreted in terms of the theory presented in Chapter Three. In particular is the notion that changes in affect and symptoms can only be effectively assessed and interpreted if they are monitored in a detailed way. Equally important is the notion that the cognitive and affective interpretation of experience must be included in the assessment. Hassles explicitly include this cognitive and affective component. Before describing the aims of this study more fully, some other studies which have used measures of hassles will be briefly discussed. Some of these, in the context of methodology and theory, have already been mentioned in Chapters Two and Three.

Previous studies of hassles have varied in terms of the frequency of assessments, the method of obtaining reports of hassles or daily events, and types of relationship examined. Repeated assessments have been made on a daily basis (e.g. Bolger et al, 1989; Caspi et al, 1987; Clark & Watson, 1988; DeLongis et al, 1988; Eckenrode, 1984; Rehm, 1978; Stone & Neale, 1982) and a monthly basis (e.g. Kanner et al, 1981). Assessments have also been made as a single measurement in cross-sectional studies (Ivancevich, 1986; Rowlison & Felner, 1988). Both checklists (Bolger et al, 1989; DeLongis et al, 1988; Kanner et al, 1981) and open response format diaries (e.g. Clark & Watson, 1988; Eckenrode, 1984; Stone & Neale, 1982) have been used. Relationships examined include those between hassles and simple unidimensional measures of mood (e.g. Bolger et al, 1989; Caspi et al, 1987; Eckenrode, 1984), between hassles and positive and negative affect (Clark & Watson, 1988; Stone, 1987a), and between hassles and physical health problems (e.g. DeLongis et al, 1988).

This range of methods and measurement is reflected in the wide range of statistical techniques which have been applied to the data which is produced. For example, spectral analysis (Larsen, 1987; Larsen & Kasimatis, 1990) and relatively simple comparisons between means (Stone et al, 1985) have been used to examine weekly fluctuations in affect. In the case of the relationship between daily affect and daily hassles a number of analytic strategies and techniques have been adopted including aggregated intraindividual correlational analyses (DeLongis et al, 1988; Rehm, 1978, Stone, 1981); intraindividual and interindividual correlational analyses (Eckenrode, 1984); comparison of mean values of positive and negative affect on days of reported hassles (Clark & Watson, 1988); correlations between within-person correlations of hassles and affect, and across-person differences in mean hassles and affect (DeLongis et al, 1988); regression analysis (Eckenrode, 1984); time series regression analysis (Caspi et al, 1987); and, regression using pooled within-person variation controlling for relatively stable individual differences (Bolger et al, 1989).

As is apparent from the preceding brief review, and discussions in Chapters Two and Three, researchers have adopted a wide variety of methodological and statistical techniques to the assessment of hassles and their possible effects. Bolger et al (1989) comment that in daily hassles investigations "as in other areas of research that have been opened up by methodological innovation, more initial progress has been made in establishing field procedures...and measurement instruments...than in documenting empirical associations" (p. 809). It is likely that a variety of approaches will continue to be, and will need to be adopted, as the use of diary methodologies and measures of hassles vastly increases the number and complexity of relationships between stress phenomena which can be examined.

In the context of other hassles research, this study is unique in a number of ways. First, other studies have not made assessments of hassles as frequently as twice a day. In this sense, the study reported here is taking the level of analysis to a slightly more intense and detailed level. Second, hassles checklists for specific areas of activity, in this case using a computer, and work in general, will be developed. Other hassles checklists, while they might in part assess work hassles, tend to focus on general daily hassles. Third, while most studies, with some exceptions (e.g. Wolf et al, 1989), have used general checklists of hassles which could apply to a variety of populations, the checklists used here will be developed specifically for the participant population. The differences between this study and others which have used hassles methodology are partly the result of the research topic under examination, but also represent an attempt to extend the methodology and the theory onto a more detailed level.

Returning to the aims of this study, all empirical investigations in this thesis have twin aims; to examine the nature and extent of symptom reporting, and other assumed outcome measures, in computer-supported work, and to evaluate the adopted methodologies. The main research aim of this study was to examine, over a work session of a few hours, the level of symptoms and changes in affect in relation to work and computer hassles, and workload and other characteristics. Two important aspects of the theoretical framework of adaptive action control, presented in Chapter Three, are the emphasis on examining processes on a detailed level, and interrelationships between proximal variables which can be seen more clearly to be causally connected. The design of this study is intended to reflect these aspects, whilst at the same time remaining responsive to the demands and constraints of applied research, and the characteristics of the sample.

In addition to the diary measures taken before and after a work session, questionnaire measures of features of the computer system and working environment, job characteristics, and longer term measures of retrospective affect and symptoms were used to examine their relationship with diary measures. As discussed in Chapter Three, it is not clear how and if cross-sectional assessments of affect and job characteristics influence the reporting of these phenomena on a work session basis. One of the aims of this study will therefore be to examine the influence of these measures on mean diary measures.

In contrast to the previous study, this methodology will allow the proximal assessment of actual time spent using a computer, as well as problems experienced while using it. In addition, the context of computer use, in terms of other work activities, and other kinds of work problems can be assessed. If the computer has any influence on affect or symptoms, the nature of this influence will be considerably clearer than would be possible with other methodologies.

5.1 Method

Invitations to participate in a study, described as an investigation of the relationships between effective performance and well-being at work and the use of computer systems, were sent to a number of large manufacturing organizations. The use of checklists to record problems and difficulties, or hassles was briefly described.

A reply, agreeing in principle to participate was received from the manager of a group of information technology (IT) in-house consultants for a multinational food and confectionery manufacturer. This group consisted of some 20 IT experts and secretarial staff, who used computers to support them in carrying out work tasks. Although this sample size is small, when compared, say, to the sample size obtained in the previous study, it was considered to be suitable for this study using an intensive diary methodology, where repeated measures are used, and the data are pooled.

5.1.1 Procedure and sample

Following discussions during a visit to the manager, a detailed research proposal was sent to the manager, and agreement to participate in the study was secured. A copy of the research proposal along with a letter explaining the nature of the research, and emphasising that participation was entirely at the discretion of the individual, was then sent to each potential participant. While it is somewhat unusual to send research proposals to each participant in a study it was felt that due to the time and involvement demanded from participants in this type of study, the level of commitment should be made as clear as possible. This is partly for ethical reasons, as in other types of cross-sectional study which involve the completion of one questionnaire the demands are relatively explicit. There are also reasons unconnected with ethics. In a study which is time demanding and longitudinal it is likely that the response rate will be higher if the participant knows well in advance what they are being asked to do.

Following this contact, the data collection procedure involved two stages. Stage one involved the completion of a questionnaire, and collection of general work hassles and computer hassles for the creation of checklists. The latter was done through the use of an open format diary which asked participants where possible to list, at the end of each working day for four weeks, four computer hassles and four work hassles. Hassles were defined here as

> "any event, thought or situation which makes you aware that your goals and plans will be more difficult or impossible to achieve. Such hassles are accompanied by negative feelings such as annoyance, irritation, worry or frustration. Hassles tend to occur very frequently, and the negative feelings associated with them may last for quite a short time."

A copy of the introduction and instructions in the diary, along with a sample daily page can be found in Appendix One (A1.1). In addition to describing the hassle, they was also asked to use a small checklist to indicate what feelings were associated with the hassle, and to describe the causes of the hassle.

The second stage involved the completion of a diary on one day per week for six weeks. A copy of the instructions given to participants and a blank diary booklet can be found in Appendix One (A1.2). On each diary day, four data collection points were involved, during each of which the following materials contained in the diary were completed. As can be seen from the list below, the morning and afternoon stages were the same.

1 Arrival at work - Affect measure
2 Before lunch - Affect measure, hassles checklist, workload measure, symptom measure
3 After lunch - Affect measure
4 End of working day - Affect measure, hassles checklist, workload measure, symptom measure

Each potential participant was individually visited to make sure that they had agreed to participate, to explain the procedure, and to answer any questions about the study or the procedure. Particular days in each week for completion of the daily diary booklet were assigned to each participant, and they were asked to complete the booklet on the days assigned to them. This was to ensure an even spread of weekdays for each participant in case particular days were chosen by the participant which were unrepresentative. A folder containing six daily diary booklets, six return envelopes, full instructions, and an example of a completed booklet was left with each participant.

Although the initial potential sample consisted of 20 IT experts plus secretarial staff, by the commencement of stage one of the study, this number had fallen to 17. At the time, the company was taken over by a much larger multinational. Many employees were uncertain about their future under the management of the new company, and took the opportunity to move to jobs elsewhere. This reduction in participants continued such that by the end of stage one, 14 potential participants were left. By stage two, when potential participants were visited, this number had dropped to 13. This figure is, of course, much lower than is ideal, but here again, given the intensive nature of this study, its continuation was considered worthwhile.

The response rate for the stage one diary was 100%. While many respondents kept this diary for less than four weeks, and on many days did not record four of each type of hassle, only a sample of hassles was required to develop a checklist. The response rate for the stage one questionnaire was also 100%. However, from the 13 remaining participants at stage two, one participant did not return any diary booklets. Considering the response rate to stage two in terms of the maximum number of diaries which could have been returned, 72 (i.e. 12 x 6), 60 or 82% were actually completed and returned.

From this remaining 12, 10 were male and 2 female. The two female respondents were secretarial workers, and the remainder were IT consultants. The mean age of the sample was 39.9 years (sd = 10.9), and they had been employed for a mean of 15.3 years (sd = 8.8). Seven of the sample had been employed for 15 years or more. This supports the comment made by the manager, that the people who left as a result of the takeover tended to be younger. Eleven of the sample were educated to A level standard or above, and six had obtained degrees. The sample had been using computers for a mean of 15.5 years (sd = 8.7), and used on average just over four different types of software (mean = 4.1, sd = 1.3). They reported that they used a computer on a mean of 4.9 days per week (sd = 0.3) for a mean of 3.5 hours (sd = 2.0) per day.

In general then, this sample reported that they had been working for the organisation for quite some time, and had considerable experience of using computers, used a number of different types of software, and used a computer for just under half of the total working time.

5.1.2 Measures

Many of these measures are based on ones used in the previous study, but adapted for this sample. First, the questionnaire measures will be discussed, and then the diary measures. The stage one diary, used for the development of a checklist will be discussed in the diary measures section.

Questionnaire measures

The main reason for using questionnaire measures in addition to diary measures was to tap variables which may be associated with patterns of responses in the diary measures. Measures were selected on one of two bases. First, using the same rationale as the previous study, a number of measures generally associated with higher symptom reporting (such as chronic levels of symptoms), but peripheral to the main variables of interest, were selected as control variables. Second, those measures included in the previous study which are more psychologically relevant to symptom reporting were also included. However, because this sample was mainly composed of IT experts it was considered that measures of attitude, given the relationship between experience and attitudes in relation to computers, would be uniformly positive, and therefore uninformative. Also, measures of work benefits and planning benefits were omitted as much of the work undertaken by these participants was to actually use computers and computer applications not as a means to an end as was the case of those participants in the previous study, but almost as an end in itself. Other measures were made more sophisticated to account for the relative levels of expertise within this group. These characteristics of the group became apparent in initial discussions with the manager.

From these discussions, it also became clear that this group did use computers to support the carrying out of work tasks, but unlike the previous sample, it was taken for granted that computers would be used, and that there were no manual equivalents to much of the work they did using the computer. These differences between the two samples reinforces the point made in the last chapter, that using a computer is not a variable as the range of activities and job contexts in which a computers are used is very large.

Ideally some of the scales used in the questionnaire should have been subjected to factor analysis so that subscales could be derived. However, because of the small sample size, factor analysis is not possible. Instead, means have been calculated for the whole scale.

Distractions. Seven items, based on a previous measure (Rafaeli & Sutton, 1986), were used to tap the level of distractions typically experienced while using the computer. This measure was included in this study as a number of the sample worked in open plan offices, where the possibility of distraction is much greater. Respondents were asked to consider how often they experienced distractions from each of the following: Other people's conversations, people speaking to you, noise from printers etc, your telephone ringing, other telephones ringing, traffic outside the building, people moving about. A four point response scale was used, ranging from never (scored 0), to often (scored 3).

Workstation dissatisfaction. The same measure used in the previous study of ergonomic dissatisfaction was also used here. Items which tapped dissatisfaction with the screen and keyboard are described below in the usability measure.

Usability. Fourteen items were used in this measure. Respondents were asked what percentage of the time they found that a number of descriptions of characteristics of computer systems applied to the systems they used. The 11-point response scale ranged from 0% to 100% at intervals of 10%. The description items were as follows (an '(R)' after a description item indicates that this item was reverse scored): The commands and procedures are awkward to use (R), it is clear what the system is doing and its current status, there is only one way of doing things (R), the information displayed on the screen is unclear (R), it is possible to make serious errors (R), the response time is slow (R), it is quick and easy to move around the system, the system allows tasks to be done in the way one would choose to do them, the response time is too fast (R), it is possible to easily correct errors, the system behaves in a predictable way, the system is unreliable (R), different parts of the system are not compatible with each other (R), the input devices are easy to use.

This measure differed slightly from the one used in the previous study. A number of additional items were used to expand the range of usability concepts (some of which were found in Ravden & Johnson, 1989), and the response format was changed. If was felt that the relatively greater, and possibly professional knowledge of usability within this group should be taken into account by increasing the range of the measure. The extended response format was introduced to reflect greater diversity of software and hardware used by this group.

Somatic symptoms. These were assessed by using the somatic sub-scale of the Symptom Check List (Derogatis et al, 1973). Respondents were asked 'In the past two weeks, how much were you bothered by...' and then presented with a list of twelve symptoms. The five point response scale ranged from not at all (scored 0) to extremely (scored 4). The twelve items were as follows: headaches, faintness or dizziness, pains in heart and chest, pains in lower back, nausea or upset stomach, soreness of your muscles, trouble getting breath, hot or cold spells, numbness or tingling in parts of your body, a lump in your throat, feeling weak in parts of your body, heavy feelings in your arms or legs.

Two week retrospective affect. Two primary dimensions of affect, depressed-enthusiastic, and anxious-content were measured using an adjective checklist. The adjectives used in this checklist were taken largely from those used by Warr (1987). In addition, a third dimension of affect, fatigued-energetic was assessed. Respondents were asked to indicate on a six point response scale, ranging from never (scored as 0), to all the time (scored as 5), how much of the time during the previous two weeks they had felt each of 18 adjectives describing affective states.

The depression-enthusiasm dimension was measured using the following items: miserable, depressed, gloomy, cheerful (R), optimistic (R), enthusiastic (R). The anxiety-contentment dimension was measured using these items: tense, worried, uneasy, calm (R), contented (R), and relaxed (R). The fatigued-energetic items were: lifeless, tired, fatigued, lively (R), energetic (R), alert (R). As previously, (R) indicates that the item was reverse scored. Higher scores on each of these dimensions therefore reflects higher levels of depression, anxiety, and fatigue respectively.

Reliability and intercorrelations between questionnaire measures

Table 5.1 below shows the means, standard deviations, reliability estimates, and intercorrelations between questionnaire measures. The alpha values of all these measures was considered to be acceptable. There were some statistically significant correlations between measures. In particular between the three dimensions of affect, and between anxiety and somatic symptoms.

Table 5.1 Means, standard deviations, reliability estimates (coefficient alpha), and intercorrelations of questionnaire measures.

Measure	Alpha	Mean	SD
1 Distractions	.82	1.44	0.56
2 Workstation dissatis.	.86	1.75	0.58
3 Usability	.88	66.94	11.71
4 Somatic symptoms	.78	0.30	0.38
5 Depression	.71	1.14	0.56
6 Anxiety	.89	1.67	0.90
7 Fatigue	.76	1.62	0.61

	1	2	3	4	5	6	7
1 Distractions	-						
2 Workstation dissatis.		-					
3 Usability			-				
4 Somatic symptoms				-			
5 Depression					-		
6 Anxiety				.81	.72	-	
7 Fatigue					.87	.59	-

Only those correlation coefficients which reached significance at $p < .05$ are reported in the above table.

Diary measures

The measures of affect, workload, support, control, physical and cognitive symptoms, and hassles, included in the diary were designed partly to meet theoretical and methodological needs, but also to be relatively quick and easy to complete. For this reason, similar nine point response scales were used for all measures, and the diary itself was in an A5 booklet format.

For the purposes of analyses, the working day was divided into two, the same measures being used in each part. Each completed diary therefore contained exactly the same data on the morning session and the afternoon session.

Current affect. Fourteen items were used in this measure which, as stated above, was completed four times on each day of data collection: At the start and at the end of each work session, so that changes in affect could be assessed.

The items used in the measure of two week retrospective affect described above were also used here, except that two items (mood adjectives) were removed from each dimension. There were two reasons for the removal of these items. First, it was particularly important that all measures in the diary, including affect, were kept as short as possible because of the extra time demands which would result from the inclusion of more items. Second, it was considered that some items such as 'optimistic', and 'depressed' may not be as labile as others, and would therefore not reflect current affect. The following items were removed: depressed, optimistic, worried, contented, fatigued, energetic. Two items, irritated and annoyed, not usually found in affect checklists were added to the list used here. Annoyance and irritation, as they are relatively short-lived but reactive mood states, may be more sensitive to the occurrence of hassles than the dimensions of affect described above.

Respondents were asked to 'decide the extent to which each word applies to you right now, at this present moment'. The nine-point scale, ranging from 0 to 8, was anchored with the words 'not at all' and 'extremely' respectively.

Workload. Five questions were asked to assess workload at the end of each work period: 'how difficult did you find your work?'; 'how quickly did you have to work?'; 'how much spare time did you have?' (R); 'how much did you have to do?'; and 'how much mental effort was needed?'. The anchors for the first two questions were 'not difficult' - 'very difficult', and 'not quickly' - 'very quickly' respectively. For other questions the anchors were 'not much' - 'very much'.

Support. A single question was used: 'How much support was available to you?', anchored with the terms 'not much'- 'very much'.

Control. Here also, a single question, 'how much control did you have over your work?', with the same anchors as the previous question on support was used to assess control.

Physical symptoms. Respondents were asked the extent to which they had experienced each of the following three symptoms/problems in the preceding work period: 'headaches', 'eyestrain', and 'backpain'. The 0 to 8 response scale was anchored 'not at all' - 'very much' respectively.

Cognitive symptoms. Respondents were asked the extent to which they had experienced each of the following three symptoms/problems: 'difficulty concentrating', 'difficulty making decisions', 'difficulty remembering things'. The response scale was the same used in the above questions on physical symptoms.

Reliability of diary measures

As shown below in Table 5.2, all the diary measures had acceptable levels of reliability.

Table 5.2 Means, standard deviations and reliability estimates (coefficient alpha) of dairy measures.

Measure	Alpha	Mean	SD
Current affect			
Start of work period			
Depression	.85	1.83	1.36
Anxiety	.84	1.97	1.50
Fatigue	.87	2.40	1.63
Annoyance	.94	0.97	1.54
End of work period			
Depression	.85	2.10	1.45
Anxiety	.82	2.33	1.43
Fatigue	.89	2.85	1.66
Annoyance	.93	1.20	1.77
Work characteristics			
Workload	.78	4.89	1.40
Support[1]	-	3.59	2.66
Control[1]	-	4.69	2.62
Symptoms			
Physical symptoms	.85	0.67	1.20
Cognitive symptoms	.78	1.53	1.76
Hassles			
Work hassles[2]	-	2.06	1.38
Computer hassles[2]	-	1.14	1.32

[1]Single-item measures
[2]Reliability coefficients were not calculated as the hassles measures were not designed as scales, and therefore not necessarily intercorrelated.

Hassles. As mentioned above, during stage one of the study respondents were asked to keep diaries of computer hassles and work hassles in order to develop a checklist. While respondents were also asked to write down feelings associated with each hassle and the causes of the hassle, this information was not used in this study, mainly because of the low sample size, and because of the incompleteness of many of the entries.

Studies of daily hassles typically either involve single daily assessments, and the use of established hassles scales (Bolger et al, 1989; DeLongis et al, 1988; Kanner et al, 1981), or an open response format where the event is subsequently coded by the researchers (e.g. Caspi et al, 1987; Eckenrode, 1984; Clark & Watson, 1988). This study in contrast uses twice daily assessments of hassles, in order increase the proximity of the occurrence of hassles and ratings of affect, and also initially uses an open response methodology to develop a checklist for the specific population. This novel approach was taken for two reasons. First to meet the demands of this particular applied research topic: Hassles may be particularly suited for the assessment of difficulties during computer use which can clearly be conceptualized as, and often take the form of, discrete episodes rather than chronic difficulties. Second, the theoretical framework of adaptive action control presented in Chapter Three emphasises the need to consider the context of hassles: Checklists which are tailored to suit the particular population under study, or even perhaps the each individual, will better capture this context.

Despite the incompleteness of the stage one diaries, 163 computer work hassles, and 210 non-computer work hassles were used to develop the checklist. While these descriptions of types of hassle were used in the diaries, for shorthand, the former type of hassle will be described as computer hassles, and the latter as work hassles.

A sorting strategy was adopted in which the aim was to strike a balance between three general criteria. First, that the items in the checklist should represent as many of the reported hassles as possible. Second that the number of items in the checklist be limited, given the demands of completing such diaries. Third, that where possible, these categories should reflect underlying patterns of action control, or specific types of disruption to action control.

Descriptions of each hassle on single pieces of paper were sorted into different piles, each pile representing a different category of hassle which emerged during the sorting process. This process was repeated several times until a satisfactory balance was achieved between the above criteria.

When these participant descriptions were collected together, they were then rewritten for two reasons. First, in order to capture as many of the participant descriptions. Secondly, and more importantly they were rewritten to make the description of the hassles as affectively neutral as possible. This was to allow respondents to record the hassle, even if it was not particularly bothersome. The issue of confounding measures of hassles with measures of psychological well-being (see Dohrenwend & Shrout, 1985; Lazarus et al, 1985) cannot be resolved, but attempts, such as this, to minimize confounding remain important.

Table 5.3 Computer hassles and work hassles used in the checklist

WORK HASSLES	COMPUTER HASSLES
1 Absent work colleagues	1 Accessing E-mail
2 Expected events not occurring	2 Exiting from systems
3 Difficulty of tasks	3 Transmitting E-mail
4 Dull or monotonous tasks	4 Bugs in software
5 Your own ability or knowledge	5 Tasks taking a long time
6 Interruptions from others	6 Incompatibility between systems
7 Tasks taking a long time	7 Failure/crash of program/system
8 The type of demands placed on you	8 Slow mainframe response time
9 Being uncertain about how to proceed	9 Getting required printout
10 Unexpected events occurring	10 Your own ability or knowledge
11 Realising you have a lot to do	11 Expected events not occurring
12 Conflicts with other people	12 Doing tasks the way you want to do them
13 Letting other people down	13 Being precise in issuing commands
14 Bureaucracy or red tape	14 Making errors
	15 System documentation
	16 Slow printing
	17 Unexpected events occurring

As can be seen from table 5.3 (above), most of these categories of hassles, for example computer hassle 6 'incompatibility between systems' were quite general. Others were quite specific. For example work hassle 1 'absent work colleagues', and computer hassle 1 'accessing E-mail' (electronic mail) reflect the specific problems encountered by this group. Also, in accordance with the third criterion above, some of the items in each area of hassles are the same. For example, work hassle 5 and computer hassle 10 are the same as they reflect a general difficulty which could be encountered when attempting to perform any type of action.

In this checklist, the number of computer hassles is greater than the number of work hassles. This was partly the result of attempting to meet the first of the three criteria discussed above. The descriptions of work hassles given by respondents fitted more easily into a fairly small number of categories, whereas descriptions of computer hassles were often more specific, and hence required a larger number of categories.

Respondents were asked at the end of each work session the extent to which each item had been a hassle for them in that work period. The nine point response scale of 0-8 was anchored using the terms not at all-very much respectively. Also, a not applicable category was made available to the respondents. This was considered to be important, as not all the hassles listed could apply to all the time. Circling a 0 to indicate that a particular item was not a hassle is quite different from circling 0 to indicate that the particular item was not a hassle because it could not have occurred. For example, computer hassle items 15 and 17 which are connected with use of the E-mail system could only potentially be a problem if the E-mail system was used.

Table 5.4 Means, standard deviations, and number of not applicable (N/A) endorsements of computer hassles and work hassles used in the checklist.

	WORK HASSLES				COMPUTER HASSLES		
	Mean	SD	N/A		Mean	SD	N/A
1	1.78	2.12	11	1	0.96	2.01	19
2	2.34	2.48	9	2	0.36	0.84	40
3	2.04	2.12	0	3	0.88	2.01	42
4	2.20	2.23	2	4	0.40	1.39	51
5	1.88	2.07	0	5	1.49	2.04	29
6	2.77	2.26	4	6	1.13	1.84	52
7	2.66	2.32	3	7	1.13	2.55	47
8	1.98	2.15	2	8	0.96	1.34	28
9	1.77	2.16	4	9	0.96	2.17	74
10	2.64	2.42	10	10	1.40	1.95	25
11	2.76	2.35	2	11	1.11	1.75	36
12	1.55	1.96	2	12	1.42	1.88	29
13	1.31	1.88	10	13	0.75	1.21	31
14	1.67	1.88	9	14	0.91	1.39	31
				15	0.75	1.55	60
				16	0.49	1.59	79
				17	1.14	1.96	39

In the diary booklet (see Appendix A1.2) respondents were reminded of the definition of a daily hassle, and were asked (see Note 1 in booklet) to as far as possible separate out those which 'occurred in connection with your work when you were not using a computer system, and those that occurred in connection with your work when you were using the computer system'. The idea of non applicability of particular items was explained in note 2 of the diary booklet. 'Only circle N/A if it would have been impossible for the item to be a hassle for you this morning' (afternoon).

Table 5.4 above shows the means and standard deviations of each item. These calculations are based on data from a total of 121 morning or afternoon work sessions from the 12 respondents. Also shown in the third column for each type of hassle is the number of times the hassle was considered to be not applicable to the work session which had just finished.

5.2 Results

Data of this kind can be analysed in a large variety of ways. The exploratory nature of this study is a partial contribution to this flexibility, but as discussed earlier, the nature of these data, as repeated assessments of variables such as mood, allows a wide variety of analytical techniques to be used. In general there is almost no limit to the number of questions which can be asked of such data, and the ways in which questions can be answered. One specific limitation in this study however, is the small number of participants, making interindividual comparisons difficult. However, correlations between questionnaire measures and mean diary ratings will be examined in order to examine the possible influence of relatively stable variables on these twice daily diary ratings. Apart from these relationships, all other analyses reported here are intraindividual, based on pooling the data such that the unit of analysis becomes a person-work session, rather than a person. The pooling of these kind of data is a common technique (e.g. Bolger et al, 1989; Caspi et al, 1987; Clark & Watson, 1988; Eckenrode, 1984), which increases power, and, when individual differences are controlled, provides more compelling results than those based on cross-sectional or uncontrolled pooled diary data (Bolger et al, 1989; Kessler, 1987). The number of cases is therefore equal to the number of participants multiplied by the number of work sessions over which the diary was completed.

The analyses reported here are by no means exhaustive, and have been chosen in response to the aims of the study described above. Following some statistics describing the work sessions, three further sections will report correlations between questionnaire measures and mean diary measures, correlations among pooled standardized diary measures, and an examination of the determinants of post work session affect and symptoms using multiple regression.

5.2.1 Descriptive statistics

Data from a total of 121 work sessions were collected. Seven participants completed the diary for all 12 work sessions, and the remaining five participants completed their diaries for 11, 10, 8, 6, and 2 sessions. The mean length of a work session was 216.7 minutes (sd = 40.2). Within each work session, the mean number of minutes spent using the computer was 52.1 (sd = 48.6), working with other people was 94.01 (sd = 63.1), and working alone was 78.9 (sd = 58.8). The figure for mean number of minutes per work session using a computer translates into a daily figure considerably less than the mean of 3.5 hours per day computer usage reported in the questionnaire.

Minutes using the computer per work session was not significantly correlated with any other diary measures (see table 5.2), with the exception of a negative association with work hassles (119, $r = -.26$, $p = .005$). (All probability levels reported in the results section are two-tailed). No significant differences were found between mean scores on the diary measures in work sessions in which the time spent using the computer was either less (n = 69) or more (n = 49) than the within individual mean.

No significant differences were found between the means of the diary measures completed in morning (n = 61) and afternoon (n = 59) work sessions. Considering work sessions as a whole, there were, as expected, significant changes in levels of depression, anxiety, and fatigue over the work session. Comparison of means (paired t, n = 120 in each case) showed increases in depression ($t = 2.22$, $p = .03$), anxiety ($t = 2.86$, $p = .005$), fatigue ($t = 3.83$, $p < .001$), but no change in reported annoyance ($t = 1.40$, ns).

5.2.2 <u>Correlations between questionnaire measures and mean diary measures</u>

These correlations provide an opportunity to examine the extent to which general ratings of environmental characteristics, affect, and symptoms may be associated with responses to diary ratings.

Considering the questionnaire measures which assess environment and computer features (columns 1-3, table 5.5a), the influence of two of these are difficult to interpret. The negative correlation between distractions and computer hassles, and the negative correlations between workstation dissatisfaction and both pre and post session annoyance, and support are somewhat contrary to expectations. In the case of distractions, it may be that those people who experience more computer hassles are less aware of distractions as their attention is focused on the computer. The relationships between usability and measures of affect and physical symptoms allows for a relatively straightforward interpretation in terms of negative affectivity. On the other hand, the greater number of relationships with post-session affect does not suggest a general negative orientation, but rather the influence of low usability over the course of a work session.

Fewer relationships were found between computer work characteristics (columns 4-5) and mean diary ratings. Higher levels of computer workload were associated with lower levels of post-session annoyance, physical symptoms and work hassles. Computer responsibility was also found to be negatively related to work hassles. Although the meaning of relationships between computer work characteristics and annoyance and physical symptoms is unclear, the relationships with work hassles may reflect greater computer usage as a proportion of work time, and hence relatively fewer work hassles. As reported in section 5.2.1 above, a negative correlation was found between minutes spent using the computer and work hassles.

Two relationships were found between general work characteristics (columns 7 - 9, table 5.5a) and mean diary measures. Ratings of workload were positively associated with diary ratings of workload, and work responsibility was positively associated with post-session depression.

Table 5.5 (a) Between-person correlations of questionnaire measures and mean diary measures

Column Headings: Questionnaire variable names
1. Distractions, 2. Workstation dissatisfaction, 3. Usability, 4. Computer workload, 5. Computer responsibility, 6. Computer autonomy, 7. Work workload, 8. Work responsibility, 9. Work autonomy

	Environment & Computer Features			Computer Work Characteristics			General Work Characteristics		
	1	2	3	4	5	6	7	8	9
Pre-session Affect									
Depression									
Anxiety			-.59						
Fatigue									
Annoyance		-.61							
Post-session Affect									
Depression			-.54					.52	
Anxiety			-.65						
Fatigue			-.51						
Annoyance		-.66		-.57					
Symptoms									
Physical			-.74	-.52					
Cognitive									
Work Chars									
Support		-.69							
Control									
Workload							.68		
Hassles									
Work				-.64	-.67				
Computer	-.79								

As a result of missing data n varies from 10 participants to 12.

Correlations where $p > .05$ have been omitted from the table.

For Correlations greater than .59 and less than .73 $p < .05$. For correlations of .74 and above $p < .01$.

Relationships between questionnaire measures of retrospective symptoms and affect are reported in table 5.5b (columns 10 - 13). Somatic symptoms were negatively associated with support, while positive relationships were found between retrospective depression and workload, and retrospective anxiety and post-session fatigue. Retrospective fatigue was associated with lower levels of control and higher levels of workload, perhaps reflecting the consequence of high job demands, with low environmental control.

Table 5.5 (continued) (b) Between-person correlations of questionnaire measures and mean diary measures

Column headings: Questionnaire variable names
10. Somatic symptoms, 11. Retrospective depression, 12. Retrospective anxiety, 13. Retrospective fatigue.

	10	11	12	13
Pre-session Affect				
Depression				
Anxiety				
Fatigue				
Annoyance				
Post-session Affect				
Depression				
Anxiety				
Fatigue			.51	
Annoyance				
Symptoms				
Physical				
Cognitive				
Work Chars				
Support	-.57			
Control				-.54
Workload		.65		.71
Hassles				
Work				
Computer				

As a result of missing data n varies from 10 participants to 12.

Correlations where $p > .05$ have been omitted from the table.

For correlations greater than .59 and less than .73 $p < .05$. For correlations of .74 and above $p < .01$.

In general, the pattern of relationships between questionnaire measures and mean diary measures is somewhat unclear. No questionnaire measure was particularly influential, neither was any diary measure particularly influenced by the questionnaire measures. However, the relatively small number of significant associations suggests that the mean diary ratings are relatively independent of these more stable individual assessments of environmental and individual characteristics.

5.2.3 Within-person correlations among standardized diary measures

These and all following analyses are based on within-person variation and the unit of analysis now becomes the work session rather than the participant. In order to concentrate only on within-person variation, the effects of between-person variation need to be removed. This can be done for each variable (X) by removing the within individual mean (MX_i) from each observed score (X_o) in order to calculate a residual score (X_r) which is then used in place of X_o in analysis. This can be expressed:

$$X_r = X_o - MX_i$$

The procedure used here of calculating and analysing residual scores is similar to the procedure adopted by Bolger et al (1989) in a diary study of the effects of daily stressors on mood. However, in their study, residuals were calculated only for the dependent variables (mood). Here, to minimise all between-person variation, observed scores on all variables will be converted into residual scores.

The correlations between these residual diary scores are reported in Table 5.6 below. Consistent intercorrelations were found among concurrent measures of affect (see Table 5.6a), while correlations between pre and post session affect were lower. As anticipated, annoyance appears to be a less pervasive and less stable affective state reflected in the relative absence of relationships between pre-session annoyance and post-session affect, and vice versa, and the relatively low correlation (.19) between pre- and post-session annoyance.

Minutes spent engaged in various work activities was unrelated to either pre- or post-session affect with the exception of two negative correlations between time spent with people and pre-session annoyance, and control (Table 5.6b). The first of these negative associations could be a consequence of anticipating a work session involving meetings or having to deal with people for much of the time. The second negative relationship, with control, can be interpreted in this context: It is likely that in meetings or dealing with other people, control over work will be lessened.

A identical pattern of relationships between pre- and post-session affect, and physical and cognitive symptoms can be observed, with only two differences. The correlations between symptoms and post-session affect appear to be larger than those of symptoms and pre-session affect. Also, symptoms are only associated with annoyance in one case, in the relationship between post-session annoyance and cognitive symptoms. In general terms depression and fatigue are more strongly associated with both types of symptoms, with anxiety correlating apparently less strongly and only with cognitive symptoms. Symptoms are not associated with minutes spent engaged in various work activities (see Table 5.6b).

Table 5.6 (a) Correlations among diary measures (residuals)

	1	2	3	4	5	6	7	8
Pre-session Affect								
1. Depression	-							
2. Anxiety	.75	-						
3. Fatigue	.71	.52	-					
4. Annoyance	.56	.73	.29	-				
Post-session Affect								
5. Depression	.43	.25	.39		-			
6. Anxiety	.31	.25	.25		.76	-		
7. Fatigue	.34	.29	.57		.72	.53	-	
8. Annoyance	.28			.19	.68	.73	.36	-
Minutes working with:								
9. Computer								
10. People				-.19				
11. Own								
Symptoms								
12. Physical	.24		.41		.32		.43	
13. Cognitive	.32	.24	.49		.42	.32	.52	.25
Work Chars								
14. Support			.23					-.19
15. Control					-.37	-.35	-.22	-.34
16. Workload							.20	
Hassles								
17. Work	.30	.26	.36	.27	.46	.52	.41	.54
18. Computer					.25	.39		.31

As a result of missing data, n varies from 87 to 121.

Correlations where $p > .05$ have been omitted from the table.

For reported correlations less than .23, $p < .05$. For correlations between .24 and .30, $p < .01$. For correlations of .31 or greater, $p < .001$.

With two exceptions, work characteristics were found to be associated only with post-session affect. One of these exceptions, a negative relationship between control and minutes spent with working with people has already been discussed. The other exception is a positive association between support and pre-session fatigue, which is difficult to interpret. The most consistent relationships were negative, and between control and all four post-session affect measures. Additional correlations were found between workload and post-session fatigue (positive) and between support and post-session annoyance (negative).

Work hassles were associated with both pre- and post-session affect, though correlations with post-session affect appear to be stronger. Studies of the relationship between daily hassles and mood have found correlations such as .27 (DeLongis et al, 1988), .22 (Eckenrode, 1984), and .23 (Caspi et al, 1987) between hassles and mood. The correlations reported here between work hassles and post-session affect, ranging from .41 to .54, are of a higher magnitude. This is probably due to the proximity of the affect assessment to the hassles. Work hassles were also associated with cognitive symptoms (see Table 5.6b). Computer hassles were, however, only associated with post-session affect, with the exception of fatigue. This suggests that the reporting of computer hassles is independent of pre-session affect, whereas work hassles are not. Such an effect may occur if people are better able to anticipate general work hassles than computer hassles, or if affect can influence the extent to which work hassles occur. Both types of hassles were associated negatively with control and positively with workload (see Table 5.6b).

Table 5.6 (Continued) (b) Within-person correlations among diary measures (residuals)

	9	10	11	12	13	14	15	16
Minutes working with:								
9. Computer	-							
10. People	-.37	-						
11. Own	-.26	-.52	-					
Symptoms								
12. Physical				-				
13. Cognitive				.49	-			
Work Chars								
14. Support						-		
15. Control		-.29					-	
16. Workload								-
Hassles								
17. Work					.31		-.39	.37
18. Computer							-.28	.24

	17	18
Hassles		
17. Work		-
18. Computer	.51	-

As a result of missing data, n varies from 87 to 121.

Correlations where $p > .05$ have been omitted from the table.

For reported correlations less than .23, $p < .05$. For correlations between .24 and .30, $p < .01$. For correlations of .31 or greater, $p < .001$.

In general, these correlations show a number of relationships between the variables. In particular, between affect and symptoms, and affect and hassles, and post-session affect and control. No relationships between computer usage and post-session affect or symptoms were found.

5.2.4 Determinants of post-session affect and symptoms

In order to establish the pattern of relationships between these variables more clearly, regression analyses will be used to examine the determinants of post-session affect and symptoms. These six variables are most clearly the dependent variables, though all variables are actually interdependent and can be both dependent and independent.

Here, simultaneous regression, where independent variables are entered together into the regression equation, will be used to predict the six dependent variables. One independent variable previously used in analyses, minutes spent working alone during work session, is omitted here because of its relatively high correlation (-.52, see Table 5.6b) with minutes spent working with other people. Initial analyses which included both these variables were difficult to interpret, which is one of the problems associated with multicollinearity amongst independent variables (Cohen & Cohen, 1975). While two other independent variables, computer and work hassles have a correlation of a similar magnitude, there are logical and theoretical reasons why both these variables should be included. This is not the case here, as they are clearly interdependent. One of a number of solutions the problems of multicollinearity suggested by Wampold & Freund (1987) is to remove one of a pair of highly correlated variables from the analysis if the pair can be considered to be in some way empirically or theoretically overlapping. This suggestion was adopted here, and one of these variables, minutes spent working alone, was dropped from the analysis.

Tables 5.7a and 5.7b below present the results of regression analyses of each of the six dependent variables on the independent variables. The proportion of variance in post-session measures of affect accounted for by the independent variables ranged from 31% to 34% (adjusted R^2, Table 5.7a), all of which were significant. In the case of physical and cognitive symptoms however, the proportion of variance accounted for was lower (see Table 5.7b) at 11% and 22% respectively.

Table 5.7 (a) Standardized regression coefficients of diary measures predicting post-session affect and symptoms

	Post-session affect			
	Dep	Anx	Fat	Annoy
Pre-session Affect				
Depression	.456***	.288**	-.162	.429***
Anxiety	-.098	.228	.123	-.213
Fatigue	.047	-.090	.540****	-.182
Annoyance	-.157	-.334***	-.057	.010
Minutes work with:				
Computer	-.018	.055	-.022	.035
People	-.066	.010	.041	-.025
Work Chars				
Support	-.031	-.114	.051	-.131
Control	-.216**	-.173**	-.037	-.184**
Workload	-.076	.027	.081	-.018
Hassles				
Work	.285***	.359****	.201*	.458****
Computer	.047	.122	-.025	.015
R^2	.38	.40	.39	.39
Adjusted R^2	.31	.34	.33	.34
F(11, 109)	5.94	6.68	6.38	6.59
p(two-tailed)	<.0001	<.0001	<.0001	<.0001

*.05 < p < .06. ** < .05. *** < .01. **** < .001. (two-tailed)

For each of the post-session affect measures a broadly similar pattern of relationships with the independent variables emerged (see Table 5.7a). A significant predictor of post-session depression, anxiety, and annoyance, but not fatigue, was pre-session depression. While pre-session anxiety did not significantly predict any post-session affect measures, coefficients with anxiety and annoyance were approaching significance.

Pre-session fatigue predicted only post-session fatigue, and pre-session annoyance predicted only post-session anxiety. For this latter relationship the negative regression coefficient suggests that higher levels of pre-session annoyance predicted lower levels of post-session anxiety and vice versa. Annoyance is a relatively short-lived affective experience, and is likely to dissipate quickly as the source of annoyance is removed, or as aspects of the situation causing annoyance become more acceptable and/or construed differently in affective terms. High levels of pre-session annoyance therefore may be due to the effects of anticipation of the content of the following work session. If, in practice, the work session is not as irritating or threatening as anticipated, lower levels of post-session anxiety may be reported. Low levels of annoyance could, through similar inaccuracies in anticipating the content of the work session, lead to higher levels of post-session anxiety.

Minutes spent engaged in either using the computer or working alone did not predict post-session affect. Of the three work characteristics, support, control and workload, only control predicted post-session affect. Significant regression coefficients (all negative) were found between control and depression, anxiety, and annoyance but not fatigue.

The strongest and most consistent predictors of post-session affect were work hassles, while no influence of computer hassles on post-session affect was found. The strongest coefficients were found between work hassles and anxiety and annoyance.

Table 5.7 (continued) (b) Standardized regression coefficients of diary measures predicting post-session affect and symptoms

	Symptoms	
	Physical	Cognitive
Pre-session Affect		
Depression	.026	-.062
Anxiety	-.024	.062
Fatigue	.415***	.520****
Annoyance	-.177	-.080
Minutes work with:		
Computer	-.020	.061
People	-.149	.096
Work Chars		
Support	-.060	-.111
Control	-.119	.044
Workload	.045	-.068
Hassles		
Work	.029	.152
Computer	-.070	.034
R^2	.195	.291
Adjusted R^2	.114	.220
F(11, 109)	2.40	4.07
p(two-tailed)	.01	.0001

*.05 < p < .06. ** < .05. *** < .01. **** < .001. (two-tailed)

Only fatigue was found to be significantly associated with symptoms (see Table 5.7b). Compared to post-session affect, this relative absence of relationships between the independent variables and symptoms, and the lower proportion of variance accounted for, suggests that the reporting of symptoms at the end of a work session is less predicted by the content of the work session, and more by the state at the beginning of the work session. Pre-session fatigue was not particularly predictive of post-session affect, with the exception of fatigue, but in the case of symptoms is appears to be uniquely predictive.

A number of interpretations of these findings can be made in the context of the relative stability of fatigue over a work session (see the correlation of .57 between pre- and post-session fatigue in Table 5.6a). First, in the case of physical symptoms, it may be that higher levels of fatigue are associated more generally with higher levels of self-focussed attention towards physical states. Awareness of such fatigue may lead to a heightened awareness of other physical states, such as headaches, eye-strain and backpain. Second, for both types of symptoms, fatigue may be understood or defined by people in terms of symptoms: One may know that one is tired, say, when one has aches and pains, or difficulty concentrating. In this interpretation, fatigue may not cause symptoms, but the two are inseparable. Third, a more straightforward interpretation is that fatigue at the start of a work session causes a more marked depletion of various energetic resources, thus leading to increased symptoms at the end of a work session. Whatever the interpretation, the unique predictive contribution of fatigue to symptom measures is striking.

These regression analyses which control for the effects of all other independent variables in the analyses, show that in particular pre-session depression, control, and, most strongly, work hassles were significant predictors of post-session affect. However, pre-session fatigue alone significantly predicted physical and cognitive symptoms.

5.3 Discussion and conclusion

The twin aims of this study, shared by all other studies reported in this thesis, were to examine the nature and extent of symptom reporting and other assumed dependent measures in computer-supported work, and to assess the methodologies. Each of these aims be discussed in turn, in the context of the results presented above.

Before a discussion of the nature and extent of symptom and affect reporting within this sample, it should be emphasized that the small number of participants in this study limited the number and type of analyses which could be used to explore these data. Nonetheless, given these research aims, an adequate number and type of results aims were reported. There appeared to be little evidence that, for this sample, use of a computer was associated with symptom reporting or levels of affect. The negative relationships between questionnaire measures of usability and mean post-session affect measured in the diaries suggested that some aspects of computer use may influence affect. However, no differences were found in the reporting of dependent variables between work sessions in which the computer was used more or less than usual. Correlational analyses did reveal some relationships between post-session affect and computer symptoms, but these relationships were not apparent in regression analyses. In summary, there was little evidence from this group that any aspect of computer usage was associated with symptom reporting or levels of affect. In the context of other work activities, time spent using the computer and hassles experienced in relation to the computer system had no marked effects.

In assessing the methodology, one of the most striking findings was found in the examination of the relationship between the questionnaire and diary measures. Although some of the questionnaire measures were associated with mean diary measures, these associations were neither widespread nor coherent. It does not appear that, at least in this sample, relatively stable measures of environmental features, job characteristics, or retrospective affect and symptoms influenced the responses made in the diaries in any systematic way. This is of extreme importance to the interpretation of the previous study, and to cross-sectional and/or non-intensive studies of the relationships between environmental characteristics and dependent variables in general. It may be the case that the relationships which can be found between environmental or individual characteristics and dependent variables in general, as is done in cross-sectional studies, are quite independent of, and unrelated to what occurs on a day-to-day or hour-to-hour level. This possibility makes the interpretation of these studies very difficult, as the information derived from them is assumed to reflect what is the respondent actually experiences. The difficulties of generalizing from one level to another are also apparent in measures of work characteristics. Measured on the level of the work session they appear, with the exception of control, to be largely unrelated to these affect, and completely unrelated to symptoms.

On a more specific methodological level, the separating out of affect into dimensions proved useful. Other comparable studies often only use single items, such as asking the participant to rate how their spirits were during the day (e.g. Caspi et al, 1987; DeLongis et al, 1988), or sum the ratings of a number of affect adjectives into a single measure (e.g. Bolger et al, 1989) to assess daily affect. In this study, different patterns of relationships emerged which would be lost if only a single general measure of affect had been used. For example, fatigue alone played a central role in the reporting of symptoms.

The hassles checklists had face validity: They were generated by the participants, and reflected the participants experience, though computer hassles were endorsed far less than work hassles. The importance of allowing the respondent to indicate if the hassle was not applicable to them can be seen in the number of times this response was used, particularly for computer hassles. The mean hassles score used here, which excludes non applicable items, is therefore is a more accurate assessment of hassles than mean scores which do not make such a distinction (e.g. DeLongis et al, 1988). Correlational analyses showed that pre-session affect was associated with hassle reporting. The correlations were smaller than those with post-session affect, and may reflect anticipation of the content of the work session. With a larger sample, an examination of the relationships between specific hassles and affect would be possible. Affect appeared to be more responsive to work activities than levels of symptoms, and is largely influenced, with the exception of fatigue, by phenomena on some other level, or in some other sphere, such as outside work activities.

These methodologies proved usable and the results generated from them were interpretable. The use of residual scores in these analyses adds a considerable weight to the findings presented here, as the influence of individual differences has been removed. Within-person analyses provides a way of sensitively examining the finer changes and patterns of relationships which occur in peoples' experience of hassles, affect and symptoms.

CHAPTER SIX

A DAILY DIARY STUDY OF WORK ACTIVITIES AND WORK CHARACTERISTICS, DAILY HASSLES, AFFECT, AND SYMPTOMS

6.0 Introduction and aims

The previous study used a relatively small group of computer users to examine the variables associated with post-work session affect and symptom reporting. This study, while using broadly similar methodologies to those employed in the previous study, is different in ways which have marked consequences for the kind of analyses which can be carried out, and the possible interpretations which can be given to the results.

First, the sample in the previous study was composed largely of IT consultants who, though typical of certain types of user, do not use the computer as intensively as other groups. The non-intensive feature of this mainly professional group's work with computers may partly account for the failure to find any effects of computer usage on post-work session affect or symptoms. It was considered that the sample for this study should be composed of more intensive, non-professional computer users. Second, while data were pooled in the previous study, as they will be here, it was not possible to examine if the previous day's level of affect or symptoms had an influence on levels on the current day, as diaries were kept for only one day per week. Changing the unit of analysis from sampled work sessions to continuous days allows these lagged effects to be examined. In addition, daily measurement enables comparisons with other daily diary studies to more easily be made, and, on a daily basis, is less demanding for the participants than twice daily assessments. Third, while the previous study examined computer usage in the context of work, here it will be examined in the context of work and experiences outside work. A further feature of the previous study which was changed here was the relatively small number of participants. Increasing the number of participants allows between-person comparisons to more fully be made, and other types of analyses, such as intraindividual and canonical correlations, to be included.

While sharing the research aims of the previous study, and building upon and extending the findings from the previous study, additional research aims are required here. These arise from the increased opportunities for between-person analyses. In particular, a further aim which can be expressed here, was to examine the sources of between-person variance in the strength of correlations between the diary measures. This procedure has been used by DeLongis et al (1988) in a study of daily hassles, health, and mood. It is likely that the strength of the relationship between, say, daily hassles and mood, is likely to vary considerably between individuals. By calculating intraindividual correlations, an estimate of the strength of this relationship can be obtained. DeLongis et al (1988) argued that intraindividual analyses are important as "what is being asked is how a given biological or psychological system responds to stress or emotional change...each individual has its own response characteristics as well as sharing common mechanisms of response" (p. 494).

In short, the aims and scope of this study are considerably broader than those of the previous study, though the theoretical and methodological foundations remain the same.

6.1 Method

The data used in this chapter are drawn from a study which was designed to examine a number of empirical issues, some of which are outside the scope of this thesis. For example, individual differences measures, such as coping, affect intensity, and action styles, and two-weekly diary assessments of leisure and social activities, symptoms, life events, and time taken off through illness, were used in this study, but will not be described in this thesis. Instead, only those measures relevant to the aims of this study and main aims of this thesis will be described and used in analyses.

6.1.1 Procedure

The personnel department of a large organization was approached and enquiries were made about the possibilities of conducting a study into work demands and well-being among the secretarial and clerical staff of that organization. Following a number of discussions it was agreed that a list of the names and internal post addresses of the 650 clerical and secretarial staff would be provided. Following this, a presentation about the study was made to a committee meeting of the largest Trade Union within the organization, at which the proposals for the research were accepted. The Union agreed to publicise the study in its communications with members. In order to publicise the study further, a short article was written and published in the organization's internal newsletter.

A detailed letter was sent to all the employees on the list provided by the personnel department. This letter explained that participation would involve spending a few minutes each day for eight weeks completing a report on aspects of work and activities outside work, mood, and health status, in a diary, and the completion of a questionnaire. The practical details of completing the diaries were described. It was emphasized that if the participant occasionally forgot to complete the daily entry, this was not particularly important, nor was it important if the participant could not complete all 8 weeks. It was suggested that the diary could most easily be completed if it fitted into the person's daily routine, for example, just before going to bed or going to sleep. The letter included a pre-addressed postcard which all recipients were asked to return, in order to indicate whether or not they would be prepared to participate in the study. Of the 650 employees on the original mailing list, 188, or 29% agreed to participate.

A further letter was sent to these employees, thanking them for volunteering to participate. In this letter, the participants were asked for their home address, in order that each of the eight Weekly Diary Booklets could be sent there. This was to avoid delays which sometimes occurred in the internal post system, and to remove any fears about confidentiality which may have been present if the participants used the internal post system. In addition, as the participants were asked to complete their daily entries at home, it was more convenient to send the Weekly Diary Booklets to their home addresses. Each of these 188 volunteers was sent the first of eight weekly diary booklets a few days before the diary-keeping period was due to start, together with a pre-paid return envelope, which could be used in the internal or external post systems, and a set of general instructions in the form of queries with their answers. A copy of this letter and the instructions can be found in Appendix Two (A2.1). All the weekly diary booklets were similarly sent a few days before the period of diary-keeping for that particular Weekly Diary Booklet was due to start.

A total of 162 participants (86% of the volunteer sample) returned the first diary. This figure became smaller as the study progressed. A number of participants dropped out because they no longer wanted to participate, a number left the organization, and others were unable to complete the Diaries for all eight weeks due to holidays or other commitments. 122 participants (65% of the sample) completed and returned at least seven Weekly Diary Booklets.

Given the demands made on the participants, and the fact that the study took place over a popular holiday period (8 May to 2 July), the completion of at least seven Weekly Diary Booklets by 122 participants shows considerable investment of effort and dedication by these participants. This effort is, in part, a reflection of the feedback and encouragement given to the participants whenever contact was made throughout the study. Individual feedback was given where the participant appeared to have misunderstood the instructions (each of the early returned Weekly Diary Booklets were checked), and general feedback was given in all the letters sent out with the Weekly Diary Booklets. As emphasized by Verbrugge (1980) in a review of health diary methodology "when respondents are monitored and given active encouragement throughout the diary period, they produce diaries with few missing and unclear responses" (p. 91).

6.1.2 Participants

Only the data from participants who met two criteria were used here. The first criterion was that participants must have completed at least seven Weekly Diary Booklets. It was considered that this group were likely to have produced more reliable data than those who missed a number of days or weeks. The second criterion was that participants should be computer users.

Of the group of 122 who completed at least seven Weekly Diary Booklets, 93 were defined as computer users (see below), and only two participants were male. The mean age of the group was 39.2 years (sd = 11.0), and had been working for the organization for a mean of 6.8 years (sd = 6.0). 75% of the group were married or living with a partner, and 58% had one or more children. The mean number of hours worked per week was 31.3 (sd = 6.8), and 29% of the sample worked part-time. 67% were secretaries, 17% library assistants, and 13% clerical officers. Participants used computers on a mean of 4.5 days per week (sd = 1.2), with 79% of participants reporting that they used a computer every working day. The mean number of reported hours usage per day was 3.6 hours (sd = 1.6). 27% of the sample received no formal training on the computer systems they used, and the mean number of hours training received for the whole sample was 9.3 (sd = 15.3).

6.1.3 Questionnaire Measures

As mentioned above, in the description of the procedure, participants were also asked to complete a questionnaire. This was posted, with a pre-paid return envelope, to all participants at the end of the diary keeping period. 121 participants of the 122 in the sample completed and returned the questionnaire. The main purpose of including a questionnaire was to gather information about the use of computers in the respondents' jobs.

Hardware and software. In the previous studies, each sample was fairly homogeneous and limited in respect of the variety of types of hardware and software used. In this study it was considered that there might be differences between participants in the variety of their use of hardware and software which could be examined in the context of affect and symptom reporting. Respondents were asked to indicate how often they used various types of hardware (e.g. mainframe terminal, personal computer) and software (e.g. word processor, spreadsheet). Lists of 7 types of hardware and 9 types of software were presented, and respondents were asked to indicate on a five point response scale from never (coded 0) to very often (coded 5) how often they used each of the types of hardware.

Participants were placed into groups using cluster analysis (see Everitt, 1974) on the basis of their scores on the hardware and software variables. A hierarchical agglomerative clustering technique was used, which successively groups individuals together on the basis of similarity scores, so that the number of groups decreases at each stage until all individuals are placed in the same group. The optimum number of groups was determined by using Ward's method, where within-group error, measured by the sum of squared deviations of each individual's score from the mean for that group is calculated at each stage of agglomerative process. A sudden increase in within-group error "indicates that relatively disparate groups have been combined at that stage" (Borgen & Barnett, 1987, p. 457), and that the minimum number of groups has been reached at the previous stage.

In this case, the optimum number of groups was found to be three. The first group (n = 21), was composed of those participants who, in contrast to the other groups, used a variety of hardware and software. Members of the multi-applications group, as it will now be referred to, in contrast to the other groups, tended to use both mainframe and personal computers, a mouse, dot-matrix and laser printers. Their software use was also more varied, including word processing, spread sheet, and accounts packages. The second group, the word processing group (n = 54), used, almost exclusively, a personal computer with a dot matrix printer, and word processing software. The third group, the library group (n = 15) only tended to use a mainframe and light pen (for reading barcodes on library books), and word processing and data base software.

Distractions. The seven item scale used in the previous study was also used here. It was thought likely that some of the sample would work in open plan offices, and experience interruptions.

Workstation dissatisfaction. Measures of workstation dissatisfaction and keyboard and screen dissatisfaction, used in both previous studies, were combined here to form a general measure of workstation dissatisfaction.

Usability. A measure of usability broadly similar to the one used in the previous study was used. However, the wording of and terms used in some of the items was changed slightly, and two items were dropped, in order to make it more relevant to a general population of computer users. For the same reason, the response scale was changed from a ten point 'percentage of the time' format, to a scale which ranged from hardly ever/never (scored 1) to most/all of the time (scored 5).

Computer attitudes. The four item attitude measure, used in the first study of GPs and receptionists was also used here.

Computer symptoms. The three measures of affective, muscular, and headache symptoms, reported as experienced while using the computer, were the same as those used in the first study.

Reliability of questionnaire measures

Table 6.1 below shows the reliability and intercorrelations between questionnaire measures. All of these measures had acceptable reliability.

Table 6.1 Reliability estimates (coefficient alpha), means, standard deviations, and intercorrelations of questionnaire measures

Measure	Alpha	Mean	SD
1 Distractions	.79	2.20	.78
2 Workstation dissatis.	.74	2.28	.56
3 Usability	.73	3.85	.52
4 Computer attitudes	.78	4.26	.62
Computer symptoms			
5 Affective	.78	.57	.53
6 Muscular	.70	.49	.43
7 Headache	.59	.96	.55

	1	2	3	4	5	6	7
1 Distractions	-						
2 Workstation dissatis.	.24	-					
3 Usability		-.42	-				
4 Computer attitudes		-.26	.35	-			
5 Affective	.32	.29	-.38		-		
6 Muscular		.22				-	
7 Headache	.30			-.22	.31	.21	-

Note: Only those correlation coefficients which reached significance at $p < .05$ are reported in the above table.

6.1.4 Designing the Weekly Diary Booklet

As participants were required to make entries in the Weekly Diary Booklet every day for 56 days it was considered that the most important design criterion should be ease and speed of use, so that the demands made on the participants each day were minimized. First, the booklet (a photocopy of the instructions and a blank of one day in the Diary can be found in Appendix Two (A2.2) at 150mm x 210mm was quite small, so that it could easily be carried around, and used on small surfaces. Second, on the card cover of the

Booklet, the instructions for completing a days entries, including definitions, and an example of a rating scale, were printed. This was done so that the Booklet could be used independently of any other materials. The card cover could also be folded out and used as a bookmark, so that participants could open the booklet immediately at the correct day. Third, the same ten point response scale was used throughout the diary. It ranged from 0, indicating not at all, or the verbal anchor placed on the left hand side of the scale, to 9, indicating very much, or the verbal anchor placed on the right of the scale. Fourth, all the places in the diary where the participant was required to make a response were enclosed in a box. Fifth, the Diary was designed so that almost all the responses could be made by circling numbers or letters. Sixth, all the measures contained a relatively small number of items. While some important information may have been missed, it was of higher priority in the design of the Diary to ensure that participants were not discouraged from continuing to complete the diary.

All the measures used in the Diary were relevant to this thesis with the exception of two items which measured personal effectiveness (section 1.3 in the Diary), and four items which measured various aspects of the previous nights sleep (section 3.2), which will not be discussed here.

6.1.5 Diary measures

Time spent on work activities and total time spent at work.

Participants were asked to indicate, by circling one of six time descriptors, approximately how many hours they had spent at work engaged in each of six activities; computer-based work, typewriting, using other machines, paper work, physical work and working with people. Six categories were used in the response scale, which were coded as follows: '0 Hrs' (0); '< 1 Hr' (0.5); '1 - 2 Hrs' (1.5); '2 - 3 Hrs' (2.5); '3 - 4 Hrs' (3.5); '> 4 Hrs' (4.5).

For assessing total time spent at work, participants were required to write a figure in the Diary. Where possible, the total hours spent at work was measured by totalling the times spent on each work activity. However, sometimes, because of inaccurate reporting, this total exceeded 12 hours. In this case, the figure written down by the participants was used.

Work characteristics. The standard ten point response scale, anchored at the left with the words 'not at all' and the right with the words 'very much' was used for assessing work characteristics. Participants were asked about five characteristics; 'cognitive', 'emotional' and 'physical' demands, 'personal control' and 'personal support'. In the instructions, printed on the inside of the card cover, it was emphasized that these ratings should be made as objectively as possible. Also printed on the inside of the card cover (see Appendix A2.2) were example-based definitions of the five characteristics were given.

Daily Hassles. The hassle items used here were broadly based on items used in scales developed by DeLongis, Lazarus, Folkman and their colleagues (DeLongis et al, 1982; Kanner et al, 1981), and in particular on items in the more recent, and considerably shorter Hassles and Uplifts Scale (DeLongis et al, 1988). The necessity to keep measures short meant that only 16 items were used. Most of these were selected for their general applicability, but two (hassles 6 and 7 in Table 6.2 below) were included specifically because of the topic of this study.

As in the previous study, a 'not applicable' category was also used. In the instructions on the card cover of the diary, two reasons were given as to why this category might be used: First, if the item could not apply on that particular day; and second, if the item could not apply to the participant at all. A similar definition of daily hassles to that used in the previous study was given here.

Table 6.2 Means, standard deviations, and number of 'not applicable' (N/A) endorsements for the items in the daily hassles scale

Item	Mean	sd	No. of N/A
1 My work colleagues	1.71	2.12	53
2 My work supervisors or employers	1.53	2.22	64
3 The nature of my work	2.67	2.60	17
4 My workload	3.02	2.97	35
5 Meeting deadlines	2.83	2.97	85
6 Using computer/wp	1.35	2.03	187
7 Using other equipment	0.71	1.48	194
8 Clients or customers at work	1.06	1.79	306
9 My partner or spouse	1.01	1.79	620
10 Family or relatives	0.61	1.30	189
11 Friends and neighbours	0.65	1.60	135
12 Housework	1.17	1.71	232
13 My children	1.50	2.06	1470
14 Financial circumstances	1.52	2.18	8
15 My health	1.40	1.92	28
16 My physical appearance	1.33	1.91	43

Note: n = 3156

Scores from the first eight items and last eight items were summed, and the means of each were used to make work hassles and non-work hassles scores respectively. It is perhaps worth noting here that the mean hassle rating given using the computer/WP (item 6) is relatively low. Only hassles with clients or customers and hassles with other equipment have a lower mean score. On this measure alone, it would appear that using the computer is not rated as particularly problematic or troublesome relative to other possible sources of difficulty at work.

Affect. Eight items were used to assess affect. The anchors on left and right of the ten point response scales were as follows: 1. 'tired' - 'alert' (R); 2. 'calm' - 'tense'; 3. 'interested' - 'disinterested' (R); 4. 'anxious' - 'relaxed' (R); 5. 'enthusiastic' - 'depressed'; 6. 'energetic' - 'fatigued'; 7. 'miserable' - 'cheerful' (R); 8. 'detached' - 'involved'. (R) indicates that the score on this item was reversed. As in the previous study, scores for depression (items 5 + 7), anxiety (items 2 + 4) and fatigue (items 1 + 6) were calculated, but in addition, a measure of involvement (items 3 + 8) was used, to indicate the extent to which participants had been engaged in their work and other activities.

Symptoms. Participants were asked to indicate if they had experienced, however slightly, any of a list of fifteen symptoms that day. A 'yes' response was coded 1, and a 'no' response was coded 0. This list was subjected to principal components analysis, with varimax rotation. Five symptom factors emerged: Cognitive symptoms ('difficulties concentrating', 'difficulties with memory', 'difficulties with making decisions'); Vitality symptoms ('feeling drowsy', 'feeling weak', 'lacking in vitality'); Somatic symptoms ('upset stomach', 'poor appetite', 'chest pains'); Neurological symptoms ('dizziness', 'headaches', 'eyestrain'); Musculo-skeletal symptoms ('muscular aches', 'back pain').

Characteristics of Diary Measures

The mean, standard deviation, and, where relevant, the coefficient alpha of each of the 23 diary measures can be found in table 6.3. With the exception of somatic and neurological symptoms, which will be omitted from most of the following analyses, the alpha coefficients suggest that these measures have acceptable reliability.

Table 6.3 Reliability estimates (coefficient alpha) means, and standard deviations of Diary measures

Measure	Alpha	Mean	SD
Work activities			
1 Computer-based work	-	2.10	1.64
2 Typewriting	-	0.65	0.98
3 Using other machines	-	0.54	0.73
4 Paper work	-	1.55	1.34
5 Physical work	-	0.43	0.72
6 Working with people	-	0.91	1.12
7 Total hours	-	6.83	1.51
Work characteristics			
8 Cognitive demands	-	5.13	2.48
9 Emotional demands	-	3.17	2.27
10 Physical demands	-	2.21	2.27
11 Personal control	-	5.84	2.44
12 Personal support	-	4.38	2.69
Hassles			
13 Work hassles	.78	1.85	1.52
14 Non-work hassles	.65	1.15	1.08
Affect			
15 Depression	.78	3.16	1.69
16 Anxiety	.82	3.55	1.97
17 Fatigue	.81	3.82	1.94
18 Involvement	.75	5.88	1.70
Symptoms			
19 Cognitive	.69	0.16	0.28
20 Vitality	.68	0.22	0.32
21 Somatic	.39	0.05	0.15
22 Neurological	.37	0.14	0.20
23 Musculo-skeletal	.60	0.24	0.36

Alpha coefficients for measures 1-14 were not calculated as they are single item measures.

n = 3156

Table 6.4 below shows the correlation coefficients between work measures and affect and symptom measures. These correlations are reported here to indicate some of the measurement properties of these diary measures, rather than as results. The majority of results reported in the next section will be based on residual, rather than raw scores.

Table 6.4 Correlations of diary work activity, work characteristic, and hassles measures, with affect and symptom measures

Column Headings: Diary variable names
15 Depression. 16 Anxiety. 17 Fatigue. 18 Involvement. 19 Cognitive. 20 Vitality. 21 Somatic. 22 Neurological. 23 Musculo-skeletal.

	Affect				Symptoms				
	<			>	<				>
	15	16	17	18	19	20	21	22	23
Work activities[1]									
1 Comp									.11
2 Typing									
3 Machines			.10						
4 Paper									
5 Physical									
6 People									
7 Hours					.12			.13	
Work characteristics									
8 Cognitive	-.11		-.12	.23	.10				
9 Emotional	.15	.37	.10		.15				
10 Physical		.11							
11 Control	-.25	-.22	-.20	.26					
12 Support	-.23	-.13	-.13	.28					
Hassles									
13 Work	.20	.34	.18		.17	.11		.17	
14 Non-work	.30	.34	.24	-.25	.11	.19	.16		

[1]For full names of variables in rows (labelled 1-14) see table 6.3.

Because of missing data, n ranges from 3112 to 3151.

Correlations smaller than .1 have been omitted from the table. All correlations are significant at $p < .0001$.

The general absence of correlations of .1 or larger between these measures, with the exception of the relationships between affect and job characteristics and hassles, and between symptoms and hassles, suggests that these measures are not interrelated in any simple or uniform way. For example, longer working hours are not generally associated with higher levels of affect or symptom reporting. However, it does suggest that affect may be influenced by and influence the rating of certain kinds of events during the working day, such as control and support. This issue will be raised again in the results section.

6.2 Results

As pointed out in the last chapter, data of this kind can be analysed in a large number of ways. However, as the research questions addressed here are similar to those addressed in the previous chapter, some of the same analyses will be performed. In addition, the larger and more diverse sample enables further between person comparisons to be made.

As in the previous chapter, most of the analyses presented here will be based on residual data in which the effects of individual differences and other trends have been removed.

6.2.1 Between-person correlations between questionnaire measures and mean diary measures

An important question is the way in which reports made on a daily basis of, say, symptoms, may be associated with reports in cross-sectional questionnaire measures. Table 6.5 below shows these kind of relationships. Two symptom measures, neurological and somatic have been omitted from this analysis because of their relatively low reliability estimates.

In general, the significant associations found were not particularly strong, with no variable accounting for more than 14% of the variance in any other, with the exception of the relationship between mean diary reports of musculo-skeletal symptoms and the questionnaire measure of muscular computer symptoms where the correlation was .52 (accounting for 27% of the variance).

Few associations were found between mean hours engaged in work activities reported in the diaries and questionnaire measures. There was however a significant association between mean time spent computing and muscular computer symptoms. Mean total time was also associated with muscular computer symptoms, as well as distractions. Few associations were found also between mean ratings of work characteristics and questionnaire measures. Emotional demands were significantly correlated with distractions and affective computer symptoms, while control was negatively associated with headache computer symptoms. Work hassles were positively associated with distractions and affective computer symptoms, and negatively with usability.

Table 6.5 Between-person correlations of questionnaire measures and mean diary measures.

Column headings: Questionnaire variables names
1. Distractions, 2. Workstation dissatisfaction, 3. Usability, 4. Computer attitudes, 5. Affective computer symptoms, 6. Muscular computer symptoms, 7. Headache computer symptoms

	1	2	3	4	5	6	7
Work activities[1]							
1 Computing						.28	
2 Typing				-.36			
3 Machines							
4 Paper							
5 Physical							
6 People							
7 Hours	.31					.25	
Work characteristics							
8 Cognitive							
9 Emotional	.26				.22		
10 Physical							
11 Control							-.24
12 Support							
Hassles							
13 Work	.23		-.28		.27		
14 Non-work							
Affect							
15 Depression							
16 Anxiety					.28		
17 Fatigue		.26	-.24		.27		
18 Involvement							
Symptoms							
19 Cognitive	.30				.38	.20	
20 Vitality					.25	.32	.29
23 Musculo-skel.						.52	

n = 93

[1]For full names of row variables in see table 6.3

Correlations where p > .05 have been omitted from the table.

For correlations greater than .23 and less than .26 p < .05. For correlations of .27 and above p <.01

A greater number of relationships were found between the mean ratings of affect and symptoms in the diaries and the questionnaire measures than were found in the previous study. These relationships are difficult to interpret as in this study, participants were asked in the questionnaire to report symptoms experienced while using the computer, while in the previous study, they were asked in the questionnaire about general symptoms over the previous two weeks. Mean diary reports of anxiety and fatigue were associated with affective computer symptoms, and fatigue alone was positively associated with workstation dissatisfaction and negatively with usability. This latter relationship was also found in the previous study, though there were many more statistically significant relationships between usability and the mean diary measures than were found here. Mean cognitive symptoms were associated with distractions, and six out of nine correlations between the three diary symptom measures and questionnaire computer symptom measures were found to be significant.

A similarity between these results and those of the previous study can be found in the lack of overall pattern of relationships between questionnaire measures and diary measures.

6.2.2 <u>Computer usage and membership of user group</u>

This section will examine some of the effects of computer usage on mean diary measures. It is interesting to note here that, as was found in the previous study, the number of hours daily usage reported in the questionnaire was higher than the mean number of hours reported in the diary. In the questionnaire, participants were asked to report how many hours they used the computer, on those days when they actually used the computer. The mean figure given here was 3.6 hours (sd = 1.6), yet from the diaries, the mean number of hours usage reported for those days when the computer was used at all was 2.6 (sd = 1.4). In terms of daily reported usage, this group is comparable with the group in the previous study who reported approximately two hours usage per day.

Considering the effects of computer usage first (as reported in table 6.4 above) no significant correlations were found between time spent using a computer each day and any of the measures of affect or symptoms. Comparing days where computer usage time was either at the intraindividual mean level or less than the intraindividual mean level (n = 1678) or more than the intraindividual mean level (n = 1478) a small number of significant differences were found among the measures of work characteristics and affect and symptom reports. Differences were found between these two types of day in two of the five measures of work characteristics (see Table 6.3). Greater cognitive demands ($t = -4.63$, $p < .001$) and less physical demands were reported for days where the computer was used more than the intraindividual mean. For the four measure of affect, one significant difference was found: On days where usage was greater, a higher level of involvement was reported ($t = -2.08$, $p < .05$). Likewise, among the three measures of symptoms one, muscular symptoms, was higher ($t = -2.31$, $p < .05$) on higher usage days.

The three computer user groups which were produced from a cluster analysis of the hardware and software used by the sample were described in section 6.1.3 as a multi-applications group (n = 21), a word processing group (n = 54), and a library group (n = 15). Before comparing these groups on mean affect and symptom scores taken from the diary to examine if different kinds of users report different levels of affect or symptoms, some of the differences between these groups on other mean diary measures and questionnaire measures will be examined in order to provide a fuller description of these user groups.

In terms of the average levels of reports for six types of work activities, five work characteristics, and two hassle measures (see table 6.3), the library group was most clearly different from the other two user groups. The library users reported less usage ($F(2, 87) = 10.57, p < .001$) than both the other user groups, and more paperwork ($F(2, 87) = 3.73, p < .05$), more physical work ($F(2, 87) = 5.81, p < .01$), more work with people ($F(2,87) = 3.23, p < .05$), more physical demands ($F(2, 87) = 4.76, p < .05$), and more personal support ($F(2, 87) = 2.93, p < .05$) than the word processor group. The only other difference between the groups on these measures was that the word processor group reported more time spent using a typewriter than the other two user groups, $F(2, 87) = 10.57, p < .001$).

Only one difference in the seven questionnaire measures (see Table 6.1) was found, with the word processing group reporting a higher level of disturbance than both the other groups $F(2, 87) = 3.58, p < .05$.

These results, not surprisingly, describe these groups, and in particular the library group and the word processing, as different from each other in a number of ways apart from the hardware and software they use. However, no significant differences were found between these three groups in the four affect and three symptom measures.

Few direct effects of computer usage in terms of time, or membership of a user group based on hardware and software used, were found in this sample. These findings are broadly consistent with those of the previous sample.

6.2.3 Intraindividual correlations among daily diary measures: Time spent using a computer with affect and symptoms

This section will describe the use of and report some results using within-person or intraindividual correlations. Such analyses are made possible in this chapter and this study by the larger sample size and the large number of repeated measurements.

The use of intraindividual correlations

Michela (1990) in a review of intraindividual correlational design and analysis states that a number of topics "relevant to personality and social psychology increasingly have been investigated by within-person correlational design" (p. 279). More specific to this study, intraindividual correlations have been used to examine the relationships between positive and negative affect and daily activities (Watson, 1988), daily unpleasant and pleasant events and mood (Rehm, 1978), daily experiences and mood (Stone, 1981), and between daily hassles, health and mood (DeLongis et al, 1988). In the latter study, intraindividual correlations between hassles and symptoms and mood were calculated. Correlations between these coefficients and mean scores on daily diary measures of hassles, mood, and symptoms, and questionnaire measures of psychological and social resources were examined. This type of analysis reveals some of the between-person differences associated with differences in intraindividual correlations. For example, a significant negative association was found between self-esteem and the intraindividual correlation between hassles and same-day symptoms, indicating that those with lower levels of self-esteem had higher hassle-symptom associations.

A similar approach to that taken by DeLongis et al (1988) will be used here. Given the number of variables measured in the diary, a large number of intraindividual correlations could be calculated. For the purposes of this study however, seven intraindividual correlation coefficients between time spent using a computer, and the four affect and three symptom measures, will be calculated for each person. Thus far, using aggregated data, few relationships between daily computer use and reports of affect or symptoms have been found. The use of intraindividual correlations enables further investigation of possible relationships.

Table 6.6 below gives the means, standard deviations, and minimum and maximum values of these intraindividual correlations. As a result of missing data the number of observations (days) on which they were based ranges from 21 to 41.

Table 6.6 Within-person correlations of time spent using the computer with affect and symptoms

	Mean[1]	sd	Minimum	Maximum
Computer use with				
1 Depression	-.05	.24	-.57	.51
2 Anxiety	.01	.25	-.58	.60
3 Fatigue	-.01	.22	-.56	.54
4 Involvement	.09	.27	-.50	.69
5 Cognitive	.00	.23	-.52	.68
6 Vitality	.01	.20	-.37	.55
7 Musculo-skel	.03	.26	-.45	.76

[1]Mean correlations and their associated standard deviations reported here were calculated by first converting the coefficients into Fisher's z scores, computing the mean of these z scores, and then converting the mean z back to an r score. This procedure is recommended as unconverted correlations have non-normal distributions (Cohen & Cohen, 1975).

A striking feature of these mean correlations is their small magnitude. Another notable feature is their large range. While for the correlations with anxiety and the three symptom measures the number of positive and negative intraindividual correlations was approximately equal, 53 participants (58%) had negative correlations between time spent engaged in computer use and depression, the same number had negative correlations between computer use and fatigue, and 56 participants (62%) had a positive correlation between involvement and computer use. However, few of these intraindividual correlations were statistically significant. Of 92 coefficients computed in each case, only relatively few intraindividual correlations between computer use and affect and symptom measures were significant at $p < .05$, two tailed. Both positive and negative correlations were found among the significant correlations in each case. The numbers of significant intraindividual correlations were as follows: Depression (12), anxiety (11), fatigue (11), involvement (14) cognitive symptoms (11), vitality symptoms (6) and musculo-skeletal symptoms (11). As suggested by some of the results already reported, it appears as though use of the computer has no marked or uniform effects.

The next two sections will examine two possible sources of between person variance which may account for the range and variety of intraindividual correlations.

Associations with mean diary measures

One source of variation in the intraindividual correlations may be found in the mean scores on the diary measures. Those participants who, for example, on average use the computer for longer each day may have lower intraindividual correlations between computer use and anxiety as they have adapted to higher levels of use. Another example involves participants who, on average, report higher levels of work hassles. For such participants, using the computer in addition to experiencing more work hassles could make them more reactive to using the computer than someone who reports relatively few work hassles.

A similar analytical procedure was adopted by DeLongis et al (1988) who examined the correlations between intraindividual correlations of daily hassles and affect and daily hassles and symptoms, with individual mean scores on hassles, affect, and symptoms. Here, the possible relationships between the mean values of all diary measures and the seven intraindividual correlations between computer use and affect and symptom measures will be examined. Table 6.7 below shows significant (at $p < .05$) associations between these variables.

In general few significant associations were found. This suggests that higher or lower intraindividual correlations are not found in those who, for example, spend more or less time engaged in computer work, or who on average report higher or lower levels of symptoms.

Table 6.7 Correlations between within-person means on diary measures and intraindividual correlations

	Intraindividual correlations[1]						
	1	2	3	4	5	6	7
Work activities							
1 Computing							
2 Typing							
3 Machines							
4 Paper			-.21				
5 Physical						-.32	
6 People							
7 Hours							
Work characteristics							
8 Cognitive		.25					
9 Emotional							
10 Physical			-.21			-.29	
11 Control			-.26				
12 Support							
Hassles							
13 Work		.22					
14 Non-work							
Affect							
15 Depression							
16 Anxiety							
17 Fatigue							
18 Involvement		.21					
Symptoms							
19 Cognitive							
20 Vitality							
23 Musculo-skel.							

n ranges from 86 to 92

[1]Column heading numbers refer to intraindividual correlation numbers in Table 6.6.

Correlations where $p > .05$ have been omitted from the table.

For correlations greater than .21 and less than .27 $p < .05$. For correlations of .27 and above $p < .01$.

Three mean diary scores, cognitive demands, work hassles, and involvement, were positively associated with the intraindividual correlation between computer use and anxiety. One interpretation of this pattern of results is that for those participants who on average already experience greater cognitive demands, work hassles, and higher involvement, using the computer acts as an additional demand. Three mean diary scores, time spent engaged in paperwork, physical demands, and control, were found to be negatively related to the intraindividual correlation between computer use and fatigue. It is more difficult in this case to interpret why it should be that lower levels of paperwork, physical demands, and control should be associated with higher intraindividual computer use/fatigue correlations. Perhaps for the first two variables, it may be that participants who on average have lower levels of paperwork and physical demands are less accustomed with physical demands, and hence on days where the computer is used for longer experience greater fatigue. A similar interpretation is possible for the negative relationships between mean levels of physical work activities and physical demands and the intraindividual correlation between computer use/vitality symptoms.

Associations with questionnaire measures

The second source of between person variation which may account for the variance in intraindividual correlations are the questionnaire measures. For example, those with less positive attitudes towards computers, or those who rate the computer as less usable may have larger and more positive intraindividual correlations between computer use and affect and symptom measures. Table 6.8 below shows correlations between intraindividual correlations and diary measures. Only one significant (at $p < .05$) relationship was found, between the questionnaire measure of headaches experienced while using the computer and the intraindividual correlation between computer use and vitality symptoms. Although it is not the same type of symptom, it does indicate a small degree of correspondence between the questionnaire measure and what is experienced on a daily basis.

Table 6.8 Correlations between questionnaire measures and intraindividual correlations

	Intraindividual correlations[1]						
	1	2	3	4	5	6	7
1 Distractions							
2 Workstation diss.				-.20			
3 Usability							
4 Computer attitudes				.19			
Computer symptoms							
5 Affective							
6 Muscular							
7 Headache			.18			.29*	

n ranges from 86 to 92

[1]Column heading numbers refer to intraindividual correlation numbers in Table 6.6.

Correlations where $p > .10$ have been omitted from the table 6.

*Only this correlation is significant at $p < .05$.

The other three correlations have been included to indicate some other relationships, even though they are not statistically significant. The first of these, between the questionnaire measure of headaches and the intraindividual correlation between computer use and fatigue is interpretable in the same way as the relationship described above. The other two associations involving the intraindividual correlation between computer use and involvement suggest that those less satisfied with their workstation have a negative association between computer use and involvement, whereas those who have more positive attitudes towards using the computer, have a positive association between using the computer and feelings of involvement.

While, in broad terms, intraindividual correlations can be useful for illuminating the nature of between-person differences, their use here has been rather limited in two ways. First by the broad range of positive and negative values of these correlations. This range does however illuminate the great variety of experience and effects of using a computer with this group. For some, using a computer may be associated with positive affect and fewer symptoms, for others it is associated with negative affect and more symptoms, for others the effects may be extremely mixed, and still for others, there may be no relationships at all between using a computer and any measures of affect or symptoms.

A second, but related limitation of the use of intraindividual correlations in this study, is their lack of associations with other measures. However, other studies which have used similar analyses have not found a particularly large number of significant associations (see DeLongis et al, 1988). Here also, the lack of associations perhaps reveals more about the non-uniform nature of the relationship between computer use and affect and symptoms, than the use of intraindividual correlations.

6.2.4 Correlations among standardized diary measures and lagged standardized diary variables

In this, as in the previous study, the measures used in the diary will be standardized to remove the effects of individual differences. The correlations between these standardized measures will be reported and described in this section preceding their use in the regression analyses presented in section

6.2.5. In this section, some lagged correlations will also be examined. As discussed in Chapter Three, some of the effects hassles or work activities may spill over into affect and symptoms the following day. These possible effects have been examined in other diary studies of hassles and affect (e.g. Caspi et al, 1987; DeLongis et al, 1988; Eckenrode, 1987; Stone & Neale, 1984) with mixed results. In this context, it may be the case that use of the computer does not show effects the same day, but has implications for affect or symptoms the following day.

Before these standardized and lagged correlations are reported, the procedure for standardizing the variables will be described.

Standardization procedure

The results reported thus far have been based on raw scores, with some analyses examined between-person variation. All results presented from now on are based on standardized scores. In the previous study, residual scores were computed in order to remove the effects of between-person variation. These residuals were calculated using the following formula:

$$X_r = X_o - MX_i$$

Where the residual score for variable X (X_r) is calculated by subtracting the within-person mean on that variable (MX_i) from each observed score (X_o). The residual scores used in this chapter will also be standardized for week of the study, and day of the week in order to control for the possible effects of week of study and day of week. It has been shown, for example, in studies using daily health diaries, that levels of symptom reporting decline over a number of weeks (Verbrugge, 1980, 1984). For days of the week, systematic differences in reported affect have been found (e.g. Stone et al, 1985), and there is some evidence that mood may follow a seven-day cycle (Larsen & Kasimatis, 1990). In this study, because of its length, and because assessments were made every day, variance which results from week of the study and day of the week will also be removed.

The residual scores used here for each variable (X), which can be called grand residuals (X_R) are based on calculating the mean values of the residual (X_r) described above and in the previous study, for each week of the study $M_{week}X_r$, and each day of the week $M_{day}X_r$ across the whole sample, and then subtracting these means from the residual (X_r).

$$X_R = X_r - M_{week}X_r - M_{day}X_r$$

One way of further describing this processes, is that the residual (X_r) which was calculated and used in the previous study, now becomes the equivalent of the observed score. The values of X_r will have a within-person mean of 0, and will have an roughly equal number of negative and positive values. From this mean we subtract any effects due to week of study. For example, it may be the case that X_r scores where X is a symptom measure decline over the weeks. Subtracting the mean of these scores ($M_{week}X_r$) for that particular week will remove this effect statistically. Likewise, if X is a measure of affect, it may be the case that values of X_r are different on a Friday from a Monday, and the effect of day of week can be removed by subtracting the mean value of X_r for that particular day of the week.

These residuals were calculated for all diary variables. The correlations between these residual measures of work activity, characteristics and hassles, and affect and symptoms are reported below in table 6.9.

Table 6.9 Correlations of standardized diary measures of work activity, work characteristic, and hassles, with affect and symptoms

Column Headings: Diary variable names
15 Depression. 16 Anxiety. 17 Fatigue. 18 Involvement. 19 Cognitive. 20 Vitality. 23 Musculo-skeletal.

	Affect				Symptoms		
	<			>	<		>
	15	16	17	18	19	20	23
Work activities[1]							
1 Comp							
2 Typing							
3 Machines							
4 Paper							
5 Physical							
6 People							
7 Hours							
Work characteristics							
8 Cognitive		.11		.12			
9 Emotional	.17	.35			.11		
10 Physical		.12					
11 Control	-.15	-.13		.13			
12 Support	-.13	-.12		.14			
Hassles							
13 Work	.18	.35	.13		.15		.15
14 Non-work	.26	.26	.20	-.20	.14	.17	

[1]For full names of variables in rows (labelled 1-14) see table 6.3

Because of missing data, n ranges from 3105 to 3156.

Correlations smaller than .1 have been omitted from the table. All correlations are significant at $p < .0001$

The correlations presented in this Table can be compared with those in Table 6.4 (above) which contain correlations between non-standardized diary measures. While the magnitude of the correlations is smaller here, the pattern of results is broadly similar. Work activities seem to have no effect on affect or symptoms. Reported work characteristics are associated mainly with affect, whereas work and non-work hassles are associated with both affect and symptoms. One strong effect of removing variation due to person, week of study, and day of week, was to reduce the relationships between work characteristics and fatigue. Before standardization, fatigue was associated with four out of five work characteristics (see Table 6.4), but after standardization, as reported in Table 6.9 above, no correlations above .10 were found between work characteristics and fatigue.

Lagged standardized diary measures

The design of this study permits the incorporation of lagged measures into analyses which are performed in order to predict the level of affect or symptoms. Here, in accordance with the main aims of this study, lags of standardized diary measures will be used mainly to control for the effects of the previous day's level of the dependent variable in the regression analyses reported in the next section. However, some examples of other uses of lagged variables will be given. The effects of computer use, or indeed any work activity, or rating of work characteristic, may be shown in the following day's rating of affect or symptoms as spill over effects. Particularly high workload, for example, may continue to have effects on affect or symptoms the following day even if the level of workload is subsequently reduced.

These lagged correlations were computed, but no coefficients greater than .10 were found, with the exception of a correlation of .16 ($p < .001$, $n > 2338$, which applies to all other correlations reported in this section) between anxiety and the previous day's level of emotional demand. These results mirror those found for the correlations between concurrent diary variables. The previous day's level of work and non-work hassles was associated with affect on the following day (but not symptoms). The lag of work hassles was associated with one affect measure, anxiety ($r = .18$), whereas non-work hassles was associated with depression ($r = .14$), anxiety ($r = .15$), fatigue (r

= .10), and involvement (r = -.13). Clearly, these lags could be used in a number of other ways, but as the lag of computer use and all other work activities appears to be unrelated to affect or symptoms, their use will be limited to the regression analyses in the next section.

As stated above, the lags of affect and symptom will be used to control for the effects of their previous day's level of the same variable in the regression analyses. The extent to which affect and symptom measures were correlated with their previous day's level (autocorrelation) was quite consistent across all these measures. For measures of affect, the autocorrelations were as follows: depression, r = .30; anxiety, r = .30; fatigue, r = .27; involvement, r = .27. For measures of symptoms, autocorrelations were: cognitive, r = .26; vitality, r = .30; musculo-skeletal, r = .33. From these associations it appears that about 10% of the variance in the current day's level of affect and symptoms can be accounted for by the previous day's level. There were not therefore strong carry-over effects from one day to the next of affect or symptoms in this sample. These results also indicate that, in general, affect and symptom levels were not stable. Autocorrelations of a greater magnitude than those found here have been found in previous studies (e.g. Caspi et al, 1987; DeLongis et al, 1988). This may result from the use in these studies of unstandardized data, where individual differences would contribute to the size of autocorrelations.

6.2.5 Determinants of daily affect and symptom reports

In this section regression analyses will be used to determine the relative influence of work activities, work characteristics, and hassles on the four affect and three symptom measures. These analyses will be broadly similar to those used in the previous chapter.

The lag of the dependent variable was entered into each regression equation first, followed by diary variables collected on the same day. The following Tables 6.10 and 6.11 contain the standardized regression coefficients for lags and diary variables for the four measures of affect, and three measures of symptoms respectively. R^2 change is given for the lagged variable alone, and then following the addition of the diary variables. The total R^2 and F values given at the bottom of these tables are for all the variables considered together in the equation. In all cases, both the lagged variable alone, and the addition of diary variables accounted for a significant (at $p < .001$) proportion of the variance.

As in the previous chapter, the concern here is to examine which variables are significantly associated with the affect and symptom measures, when controlling for the effects of the lag of the dependent variable and other diary measures of work activities, work characteristics, and hassles.

Table 6.10 below reports the regression coefficients associated with affect measures. The previous day's level of affect in each case accounted for 8% or 9% of the variance in the current day's level of affect. After controlling for the effects of the lag, a number of other significant associations were found. Although these coefficients are small, relationships were found between using the computer and anxiety and involvement. More use of the computer was associated with lower levels of anxiety and higher levels of involvement. These associations between computer use and affect measures were not apparent in previous correlational analyses.

Other work activities which were found to be associated with affect were time spent using other machines (lower levels of involvement) and most strikingly, working with people. More time spent working with other people was associated with lower levels of depression and fatigue, and higher levels of involvement.

Table 6.10 Standardized regression coefficients for diary measures predicting affect

	Affect Measure			
	Dep	Anx	Fat	Inv
Lag	.250***	.209***	.240***	.231***
R^2 Change	.09***	.08***	.08***	.08***
Work activities[1]				
1 Comp	-.032	-.041*	.012	.047*
2 Typing	-.016	-.032	-.014	.026
3 Machines	-.003	-.004	.019	-.036*
4 Paper	.022	-.018	.023	-.023
5 Physical	.004	.010	-.025	.000
6 People	-.070**	-.014	-.037*	.083***
7 Hours	-.010	-.014	-.007	-.008
Work characteristics				
8 Cognitive	-.112***	-.028	-.070***	.126***
9 Emotional	.134***	.217***	.009	-.032
10 Physical	-.013	-.015	.007	-.003
11 Control	-.084***	-.088***	-.044*	.061***
12 Support	-.070**	-.057***	-.039*	.097***
Hassles				
13 Work	.100***	.188***	.110***	-.060**
14 Non-work	.178***	.154***	.141***	-.155***
R^2 Change	.10***	.17***	.05***	.08***
Total R^2	.19	.25	.13	.16
Adjusted R^2	.19	.25	.12	.15
F (15, 2928-2947)	46.96	66.99	27.36	34.90
p(two-tailed)	<.0001	<.0001	<.0001	<.0001

[1]For full names of variables in rows (labelled 1-14) see table 6.3

Because of missing data n varies from 2944-2963

* < .05 ** < .01 *** < .001

Cognitive demands were associated with lower levels of depression, fatigue, and anxiety, while emotional demands were associated with higher levels of depression and anxiety. It is clear here, as in the previous study that different dimensions of affect are differentially associated with patterns of demands and activities. Control and support were associated in the same way with measures of affect. Higher levels of both of these work characteristics was found to be associated with lower levels of depression, anxiety, and fatigue, and higher levels of involvement. Both work and non-work hassles were strongly and uniformly associated with affect. Reports of hassles were associated with higher levels of depression, anxiety, and fatigue, and lower levels of involvement.

Although, the proportion of variance explained by the lags was roughly equal for all measures of affect, the change in R^2 after including the diary measures was not uniform across all the affect measures. The largest change in R^2 was found for anxiety, with the diary measures accounting for a further 17% of the variance after the lag. An additional 10% of the variance in depression was accounted for by the diary variables, while the addition of the diary measures explained a further 5% of the variance in fatigue and 8% in involvement. It would appear that changes in depression and fatigue are more labile with respect to work activities than fatigue, and to a lesser extent, involvement. This pattern can be observed in the correlational analyses presented earlier, and in particular the correlations between standardized diary variables (Table 6.9).

For symptoms measures (Table 6.11 below), the total proportion of variance explained by the lags and diary measures together is generally smaller at 9% to 13%, as compared to 12% to 25%. The proportion explained by the lags alone for symptom measures is however quite similar at 9% to 10%. As with affect measures, work activities as a group had little effect on symptom measures, with the exception of musculo-skeletal symptoms, where a negative relationship with typing and a positive relationship with physical work was found.

Work characteristics had little affect on symptom measures. More cognitive demands were associated with fewer musculo-skeletal symptoms, more emotional demands with higher levels of cognitive symptoms, and higher levels of support with fewer cognitive and fewer musculo-skeletal symptoms. In general these relationships were small, and in comparison to affect measures, quite limited.

The most uniform relationships were those between hassles and symptom measures. For cognitive symptoms, work and non- work hassles have similar effects. However only non-work hassles have a significant association with vitality symptoms. This pattern is almost reversed for musculo-skeletal symptoms. Here too, different patterns of association are apparent, reflecting differing sensitivities to work activities and characteristics and hassles.

Table 6.11 Standardized regression coefficients for diary measures predicting symptoms

	Symptom Measure		
	Cognitive	Vitality	Musculo.
Lag	.262***	.281***	.294***
R^2 Change	.07***	.09***	.10***
Work activities[1]			
1 Comp	-.015	.040	.027
2 Typing	-.020	.012	-.043*
3 Machines	.016	.003	.027
4 Paper	.002	.003	.010
5 Physical	.015	-.004	.062**
6 People	-.030	-.008	.018
7 Hours	-.014	-.029	.007
Work characteristics			
8 Cognitive	.020	-.025	-.083***
9 Emotional	.053**	.005	-.008
10 Physical	-.016	.008	.005
11 Control	-.035	-.033	.021
12 Support	-.041*	-.025	-.044*
Hassles			
13 Work	.079***	.040	.121***
14 Non-work	.083***	.119***	.041*
R^2 Change	.03***	.02***	.03***
Total R^2	.10	.11	.13
Adjusted R^2	.09	.11	.13
F (15,2965-2982)	21.66	24.58	30.95
p (two-tailed)	<.0001	<.0001	<.0001

[1]For full names of variables in rows (labelled 1-14) see table 6.3

Because of missing data n varies from 2981-2984

* < .05   ** < .01   *** < .001

The addition of diary measures explained only an additional 2% to 3% of the variance in symptom reports. This suggests that in general these symptom measures are not as sensitive as affect measures to work activities or non-work hassles.

These regression analyses are in a number of ways similar to and are supported by those reported in the previous study. First, as just discussed, the difference in lability between affect and symptom measures with respect to work and other daily activities was also found in the previous study. There, between 38% and 40% of the variance in post-work session affect was accounted for by pre-session affect and work activities and characteristics, whereas only 11% to 24% of the variance in symptom measures was explained by the same variables. Second, the differential patterning of affective responses observed in this study was also observed in the previous study. Third, the uniformly strong associations found here between hassles and affect was found in the previous study, though no associations were found there, as they were here, between hassles and symptoms.

In these analyses, only two significant associations between computer use and affect or symptom measures were found. Higher levels of computer use were associated with lower levels of anxiety and higher levels of involvement. In general, the influence of computer usage on the level of affect and symptoms reported by participants is very small indeed relative to other activities and experience. This is quite consistent with other findings presented here.

6.2.6 Canonical correlation analysis

This technique provides a way of examining the mutually independent associations between two sets of variables, such as a set of independent and a set of dependent variables, or a set of variables which describe ratings of various characteristics of environments and a set of variables which describe ratings of psychological states. Canonical correlation has been described as a generalization of multiple regression analysis to any number of dependent variables (Cohen & Cohen, 1975, Kerlinger & Pedhazur, 1973). Its similarities with principal components analysis have been noted by Stevens (1986). Both types of analysis reduce data using uncorrelated (independent) combinations. In principal components analysis, the initial few linear combinations, the components, usually account for most of the total variance in the variables. Likewise, in canonical correlation, the first few linear combinations, canonical factors or variates, account for most of the variance. A third similarity between principal components analysis and canonical correlation is found in the way in which the factors and the canonical variates are interpreted. In both cases, correlations between the factors and the original variables are used to describe and interpret the nature of the factor.

This analysis is extremely useful here as measures of affect and symptoms cannot be considered to be separate or independent of each other, though because multiple regression can only be used to predict a single variable, they have been treated separately in the preceding analyses. Although the interrelationships are obviously more complicated, it will be useful here to consider the set of dependent variables as the state variables of affect and symptoms, and the independent variables as the work (plus nonwork hassle) variables.

The results of the analysis are presented in Table 6.12 below. Seven canonical variates (CVs) were computed, but only the first four of these accounted for a statistically significant proportion of the variance, and hence, only four are reported in this table. For the state variables (dependent variables) the loadings, or weights, of each of these seven affect and symptom measures on the four CVs (1 - 4) are presented in the top half of the table. The loadings of each work variable (covariates) on each CV are presented in the bottom section of the table.

Table 6.12 Loadings of state variables and work variables on four canonical variates

	Canonical Variates			
	1	2	3	4
State variables				
Depression	.668	-.571	.281	-.161
Anxiety	.949	.089	.080	-.022
Fatigue	.424	-.436	-.112	-.722
Involvement	-.398	.860	-.030	-.031
Cognitive	.420	-.042	-.056	-.235
Vitality	.294	-.280	.113	-.652
Muscular	.295	-.137	-.822	.061
Work variables				
Computer	-.023	.312	-.191	-.521
Typing	-.041	-.008	.402	-.054
Machines	.030	-.198	-.364	.108
Paperwork	.002	-.193	-.033	.217
Physical work	.186	.050	-.372	.318
People work	.111	.261	-.162	.061
Work hours	.038	.125	-.353	.033
Cognitive demands	.191	.703	.094	-.177
Emotional demands	.712	.451	.200	.281
Physical demands	.247	.149	-.231	.119
Control	-.303	.307	-.234	-.237
Support	-.271	.357	.062	-.264
Work hassles	.741	.297	-.409	-.135
Non-work hassles	.587	-.365	.149	-.570
R_c	.480**	.275**	.169**	.116*

* < .01 ** < .001

If the canonical correlation (R_C) presented at the bottom of table is squared, this resulting figure indicates for each canonical variate the proportion of variance in the weighted composite scores of the affect and symptom measures accounted for by the weighted composite scores of the work activities, characteristics and hassles measures. Those variables underlined in each CV are those which will be used in the interpretation of each CV described below.

As pointed out by Wherry (1984) canonical correlation is relatively new and a number of problems exist in interpreting canonical composites and in understanding its use and utility. However, he emphasises that the sole purpose of canonical correlation is to find a weighted composite of the variables in one set of variables which correlate maximally with a weighted composite of the variables in another set. The interpretation of this analysis depends partly on the weights produced in computation, but, as in principal components analysis, an understanding of the measures used and the theoretical reasons for using the measures, is equally important.

Canonical variate 1. The loadings on the CV1 show that it is concerned with a pattern of negative affect, in particular depression and anxiety. Fatigue and cognitive symptoms have moderate loadings, as does lower levels of involvement. Approximately 23% (the square of the canonical correlation) of the variance in this negative affect variable was accounted for by the weighted composite score of the work and hassle variables. Work hassles and emotional demands were associated with this pattern of negative affect, as, to a lesser degree were non-work hassles. The negative correlations with control and support, though low, indicate that these variables were more influential when levels of both these environmental features were low.

CV1 shows that a pattern of higher levels of emotional demands and work hassles was associated strongly with a pattern of negative affect, in particular depression and anxiety.

Canonical variate 2. The composite weighted score of the work and hassle variables explained approximately 8% of the variance in the composite affect and symptom score. This variable was characterised by low levels of, or the relative absence of depression and fatigue, and high levels of involvement. The low loading of anxiety on CV2 indicates that this pattern is not simply a reversal of the pattern found for CV1, but does indicate a positive affective state. There is quite a clear separation here between positive and negative affective states. Only two work variables, cognitive demands and emotional demands were strongly associated with this positive affective state. In contrast to the pattern for CV1, emotional demands, in this particular combination with other work demands and characteristics can increase involvement, and lead to lower levels of depression and anxiety. The weak though positive correlations with control and support, show that high cognitive and emotional demands have this effect when control and support are present. Computer work also features in this pattern, being positively and weakly correlated with this variate.

This pattern of associations between each set of variables found in this variate, which are independent of CV1, indicates that cognitive and emotional demands have effects on positive affective states. In addition, it reveals that partially similar patterns of work variables had quite different effects depending on the combination and levels of other characteristics.

Canonical variate 3. There is only one noteworthy loading on this variate, which is low levels of musculo-skeletal symptoms. The absence of a symptoms is always difficult to interpret, particularly if no other affect or symptom measures are load on this variate. Approximately 3% of the variance in this composite weighted measure was accounted for by the work and hassle variables. Quite a number of work variables are correlated with absence of fatigue, which makes it difficult to interpret and a weakly defined variate. However, it appears that less use of other machines, lower levels of physical demands, work hours and work hassles and more typing are together associated with the absence of musculo-skeletal symptoms. Although only tentative interpretation is possible of this CV, it may be the case that low muscular symptoms occur when time spent typing reduces the use of other machines, and other physical activities.

Canonical variate 4. The final canonical variate, where only approximately 1% of the variance in the composite weighted affect and symptom measures was accounted is similarly difficult to interpret. An absence of fatigue and vitality symptoms describes the pattern of affect and symptoms. Low levels of computing and non-work hassles are associated with this pattern of variables. This is perhaps one of the clearest effects of computer use thus far found, though only 1% of the variance is accounted for by the composite weighted measure which includes computer use. This pattern suggests that if computer use and non-work hassles are low, there is a relative absence of fatigue and vitality symptoms.

The most informative canonical variates are 1 and 2. This is not because they were the strongest, but because they revealed two independent patterns of associations between the sets of variables, which, although suggested by the regression analyses could not be clearly observed as they were here. The clear and independent patterns of affect found in CV1 and CV2 are similar to those discussed in Chapter Three between positive and negative affect (e.g. Diener

& Emmons, 1984; Watson, 1988b; Watson & Tellegen, 1985). The pattern of affect in the CV1, characterised by depression and anxiety is similar to high negative affect, whereas the pattern of affect in CV2, with high levels of involvement, and low levels of tiredness and depression indicates high positive affect.

Although it is not quite accurate to do so, it may be helpful to interpretation for these results to be expressed as types of days. The type of day associated with CV1 may be characterised as involving particularly high levels of anxiety and depression. Present also, but to a lesser degree is fatigue, an absence of feelings of involvement, and cognitive symptoms such as difficulties concentrating and making decisions. Experiences during the day would have been marked by a high level of emotional demands and work hassles, and to a lesser extent, non-work hassles. The type of day expressed in CV2, would be one where depression and fatigue were low, and involvement was very high. Cognitive demands would be rated as high, and emotional demands, though at a lower level, were also present. Relatively few hassles outside work would have been reported.

This kind of analysis, while adding little information to what was already known about the general absence of associations between computer use and symptoms, shows the possibilities of examining patterns of relationships between the kinds of variables collected in this kind of study. A much richer picture of the ways in which such variables may be interacting can be drawn than is available using other techniques.

6.2.7 Analytical limitations

As indicated in this and the previous chapter, data of this kind can be analysed in a large number of ways. The almost complete absence of relationships between any aspect of computer use and the any affect or symptom measure has curtailed the number and type of analyses which could be performed with such data. Other ways of analysing and interpreting such data will be discussed in the next section.

6.3 Discussion

This discussion, as in the discussions of the results of previous studies, will be divided into two parts. The first will consider these findings in the light of the research topic of the nature and extent of affect and symptom reporting in computer-supported work, while the second will consider the implications of results for the methodologies employed in this study. In addition, this section will discuss ways in which the analyses presented here could be extended.

6.3.1 Affect and symptom reports in relation to computer usage

Consistent with the other studies reported in this thesis, few effects of computer usage on affect or symptoms were found. Using pooled data, no correlations between computer usage and affect or symptom variables was found (see Table 6.4). Correlations between mean scores on the diary measure of time spent using the computer, and the questionnaire measures showed that mean time spent using the computer was associated with only one questionnaire measure, which was muscular symptoms reported as experienced while using the computer. The information about computer usage gathered from the questionnaire, such as attitudes towards the computer, or its usability, appeared to be unrelated to the time spent using the computer.

Comparing days when usage was more or less than the intraindividual mean revealed that more cognitive demands, greater involvement, and a higher level of muscular symptoms was reported on those days when the computer was used more than the intraindividual mean.

Cluster analysis was used to group users on the basis of their use of hardware and software in order to examine the extent to which different types of users might experience different levels or patterns of affect or symptoms. No significant differences were found between these groups, referred to as a multi-applications group, a word-processing group, and a library group, on the affect or symptom measures, and one difference, the level of reported disturbance, was found between these groups on the questionnaire measures. These findings suggest that the type of hardware and software used by these participants had little influence on the perceptions of the usability of the computer, dissatisfaction with, or attitudes towards, or symptoms reported as experienced while using the computer.

Intraindividual correlations between computer usage and the four affect and three symptom measures were computed to examine which between person differences could account for differences in these intraindividual correlations. The large range of these correlations, and their means, at around zero (see Table 6.6), means that there are no uniform effects of using the computer on affect or symptoms, and that about as many people have positive as negative correlations. For some people, use of the computer is associated with increases in particular measures of affect or symptoms, while for others computer use is associated with a decrease in these same measures. The potential for examining the possible reasons for these differences is increased in this study as a result of the number of measurement points, and the size of the sample. Considering first the mean diary measures (Table 6.7), the most obvious influences to examine were the effect of the mean time a participant spent using the computer on these intraindividual correlations. It may be the case for example, that those who generally use the computer less would have a higher intraindividual correlation. This was not the case, and no significant correlations between mean computer usage and any of the seven intraindividual correlations was found. Very few correlations were found between other mean diary measures and intraindividual correlations. Turning to questionnaire measures, equally plausible relationships between, say, perceived usability or attitudes and intraindividual correlations could be expected. However, only one significant correlation between questionnaire measures and intraindividual correlations was found: Higher intraindividual correlations between levels of computer usage and vitality symptoms were associated with higher levels of muscular symptoms reported as experienced while using the computer in the questionnaire (see Table 6.8).

The use of intraindividual correlations can provide a number of insights into processes not open to investigation by other means, and have been used to good effect (e.g. DeLongis, 1988; Watson, 1988) in studies of daily activities hassles, and affect. It is therefore disappointing that in the context of this study and its aims they do not reveal much of importance about the nature and extent of affect and symptom reporting in computer-supported work. However, considering the results already discussed here, and the weak associations between computer usage and other variables, it is perhaps unsurprising.

Standardizing all the diary variables for the person, the week of the study, and the day of the week, produced relatively few differences in the correlations between these measures (compare Table 6.4 and 6.9). Some correlations were smaller, and the relationships between work characteristics, hassles, and fatigue disappeared, indicating that fatigue is highly influenced by individual differences, or differences due to the week of the study or the day of week.

Some correlations between lagged variables, that is the value of the variable on the previous day, were reported. No significant associations between the previous day's work activities, including computer usage, or work characteristics and affect or symptoms were found, with the exception of the previous day's level of emotional demand and anxiety. This indicates that for this group there were few carry over effects of work activity or work characteristics to the next day's level of affect or symptoms. Work hassles did carry over to the next day's level of anxiety, and non-work hassles carried over to all four measures of affect.

These standardized measures and lags were then used in regression analyses. The lags contributed a significant and quite consistent percentage of the variance, ranging from 8% to 10%, to all seven affect and symptom measures. The addition of the diary variables likewise contributed a significant, but less consistent percentage of the variance, to all these measures, with affect measures showing greater lability. This finding corresponds with the previous study. In general, work activities were unrelated to affect or symptom measures. However, in these analyses, computer usage was shown to be significantly, though weakly, related to lower levels of anxiety and higher levels of involvement. Though weak, this latter finding is quite compelling, given that it occurred even when controlling for the lag and all other diary measures. It may be the case that using the computer increases cognitive demands. In the correlational analyses presented earlier cognitive demands were found to be associated with increased involvement, and on days where computer use was greater than the intraindividual mean a higher level of cognitive demands was reported. In the regression analyses also, higher levels of cognitive demands were associated with increased involvement. If using the computer does increase involvement and reduce anxiety, it may therefore be unconnected with the effects of computer on the process of work, but may operate through increasing cognitive demands which in turn has implications for affect.

The canonical correlation revealed little additional information about the effects of computer use, except that low levels of computer use, when combined with low levels of non-work hassles is associated, though only weakly, with low levels of fatigue and vitality symptoms.

From the analyses discussed here, it is clear that for this group, using a computer sometimes has no influence on affect or symptom reporting, sometimes it has effects, but these effects are not uniform, and, as the last regression analyses show, can lead to a reduction in anxiety and increase in level of involvement, though this relationship is neither particularly strong, nor simple. In general, in the context of work, and of hassles outside work, using the computer is an unimportant influence on affect or symptom reporting.

6.3.2 Methodological issues

As discussed above, the use of this methodology revealed few if any effects of using the computer on the participants in the study. While these results tell us little about the methodology, other results which have already been reported are much more revealing. These have not yet been discussed as they are peripheral to the research topic, but will be briefly discussed here in the context of methodology.

The use of measures which attempt to differentiate between different dimensions of work characteristics and affect and symptoms allows the detailed patterning of the relationships between these two kinds of variables, which was found here as in the previous study, to be examined more clearly. For example, proportion of variance in the affect measures explained by the diary measures varied across the affect measures. Depression and anxiety were more responsive to diary measures. On an even more detailed level, a further example, from Table 6.10, can be found by comparing the effect of different kinds of demands on different dimensions of affect. Cognitive demands had particularly strong associations with depression, fatigue, and involvement, but little effect on anxiety. Emotional demands had strong associations with depression and anxiety, but no significant association with fatigue or involvement. No significant associations between physical demands and affect measures were found. The patterns of relationships between control and affect measures and support and affect measures were broadly the same. The importance of differentiating between different components of affect and symptoms, and work characteristics was demonstrated most strikingly in the canonical correlation analysis.

Different patterns of relationships between work and non-work hassles and affect measures were found. In general it appears as though anxiety is more associated with work hassles than non-work hassles, whereas the pattern is reversed for other affect measures. This pattern is supported by the finding that the additional percentage of variance accounted for over and above the lag in an affect measure by adding the diary variables, which are mostly work variables, is greatest for anxiety. This also indicates the importance of separating out different types of hassles, or hassles from different domains, as their effects may depend on their type or in which domain they arise. For example, other distinctions could be made between relationship or people hassles, and hassles connected with task-based activities.

Using cluster analysis to group users is a novel and potentially useful way of attempting to examine if different types of systems lead to different patterns of response to those systems. This approach proved unfruitful here simply because of the lack of response of this sample generally to computer use.

Although the use of intraindividual correlations can provide important insights, and, as stated by Michela (1990) "it is difficult to imagine how any other design could provide the kind of information obtained" (p. 305), their use in this study has been severely limited by the diversity and weakness of these correlations and the small number of relationships between these correlations and other variables. While these results are in some ways disappointing, they do reveal, as discussed above, something about the nature of affect and symptom reporting in relation to computer usage for this group.

The questionnaire measures which were concerned with aspects of computer usage were not related in any revealing way to the diary measures. Here too, it may be because of the generally weak relationships between computer use and other diary measures. However, it may also be the case that, as found in the previous study, what people report in a questionnaire may be quite unrelated to what they report they experience on a daily basis.

On a more procedural level, it appeared as though the techniques used for encouraging initial and continued participation were successful, and that the

Daily Diary Booklet was usable, and the time required to complete it each day was not off-putting to participants.

These methods did not reveal many effects of computer use on affect or symptom reporting. They did however show that compared to other characteristics of work, and hassles, the effects of computer work are minimal. For this group then, the extent of affect in symptom reporting in relation to computer usage is very small. The nature of these relationships was shown to be non-uniform, with participants having widely varying intraindividual correlations. These relationships, where they were found, showed that for this group using the computer was associated with lower levels of anxiety and higher levels of involvement. It seems unlikely that such relationships could have been found by using other methods.

6.3.3 Further analyses

It is clear that more, or stronger relationships, would have required further investigation, and further analysis, using the techniques already presented here. If some of the intraindividual correlations had been shown to be associated, say, with mean diary measures, this correlation could have been used as basis for dividing the group and examining in more detail why for some people a positive intraindividual correlation exists between computer use and affect or symptoms, and why for others a negative association exists. A similar case can be made for the use of lagged variables. If some associations between the previous day's level of computer use and symptoms had been found, then this relationship could have been examined further, in the same way that lagged relationships between hassles and next-day symptoms have been used by DeLongis et al (1988).

Further analyses may have involved techniques which have not already been used here. Other comparisons could be made, and more statistical tools could be employed, as it may be the case that more complex and more subtle relationships exist between computer usage and affect and symptoms than have been thus far discovered. However, the general weakness of the relationships that do exist suggest that further analyses and exploration of these data for the purposes of addressing the research topic would be unfruitful, and difficult to justify.

6.4 Conclusion

The group of users in this sample reported that on those days that they used the computer, they used it for a mean of about two and a half hours a day, during a working day of, on average, about seven hours. For this group it appears as though using the computer has few general or strong effects on affect or symptom reports. Where it may have effects, they sometimes increase and sometimes decrease the reporting of affect and symptoms. It is likely that computer usage has little influence on affect or symptoms, and relative to other daily experiences, has almost no influence.

The methodology was shown to be extremely useful. Whilst it revealed few relationships between computer use and affect and symptom reports, it did show that demands, affective states, and hassles interact in complex ways, and that these cannot be conceptualized as single phenomena. The use of lagged variables and intraindividual correlations added further detail to the patterning of the relationships between job characteristics, hassles, affective states, and symptoms. Even more detail could have been added, if evidence of other possible relationships relevant to the research topic under investigation had been apparent.

PART THREE

This Part of the thesis contains Chapter Seven, which contains the general discussion of and conclusions to the thesis as a whole. The discussion considers the results of all the studies together, and the significance of these results for understanding the nature and extent of symptom reporting in computer-supported work, and some possibilities for further research into this topic. The Chapter then continues with a discussion of the results in two broader contexts. First, the strengths and weaknesses of the methodologies used in the latter two studies, and other methodological possibilities are described. Second, the implications of these results and methodologies for the theoretical framework described in Chapter Three are discussed. Finally, this Chapter, and the thesis, finishes with a number of conclusions concerning the future of stress research.

CHAPTER SEVEN

DISCUSSION AND CONCLUSIONS

7.0 Introduction

The main concern of this thesis was to critically examine some fundamental theoretical and methodological issues in stress research. This has been carried out in two ways. First, through an analysis of current practices in stress research and a synthesis of a number of theories, a theoretical and methodological framework was developed, described, and discussed. Second, a small part of this framework was explored by using methodologies derived from it in empirical research. The chosen topic of this research was the nature and extent of symptom reporting in computer-supported work. Three studies, one using cross-sectional questionnaire methodology, and two using diary methodologies based on some aspects of the theoretical and methodological framework were used to examine this research topic. These studies will be briefly reviewed, and the significance of the results as a whole will be discussed in the context of the research topic. Following this, the merits and problems of the methodologies employed in this empirical work will be considered, as will ways of improving upon or extending the methodologies.

The discussion surrounding the theoretical and methodological framework presented in Chapter Three will not be repeated here. As stated in Chapter Three, the framework presented was broad and comprehensive and its role was not simply to support the empirical work. It was argued that theoretical or rational approaches have tended to take second place to empirical and observational approaches, particularly in stress research, and that this balance should be redressed. These discussions will not then be repeated, but a short discussion of this framework will take place in this chapter in order to establish the extent to which it has been supported by the results, and to indicate ways in which future studies could examine parts of this theoretical framework. Finally, the implications of the results and the theoretical framework for current practices in and the future of stress research are considered.

7.1 Symptoms and affect in relation to computer-supported work

This section will review and discuss the substantive findings from the three studies reported earlier. Specific results from each study have already been discussed in each chapter. Here, a broad overview of these results, including comparison between studies, will be given, and their implications for the research topic will be discussed.

7.1.1 The studies, samples, measures and analyses

The main aim of the first study was to establish which types of variables may be associated with symptom and affect reporting in computer-supported work in order that these variables could be included in future studies. This study was largely exploratory as there is virtually no other research evidence on which to draw. A subsidiary aim was to compare the insights which could be obtained from a cross-sectional questionnaire study with those obtained from the diary studies. The sample was composed of 274 users of General Practice computer systems. A large number of measures were included in the questionnaire. Those which proved to be most strongly associated with predicting affective and headache symptoms (reported in the questionnaire as experienced while using the computer) were attitudes to the computer, its perceived usability and benefits for work, and dissatisfaction with ergonomic characteristics of the workstation and screen.

The second study involved a group of information technology consultants who worked within a large manufacturing organization. The main aim of this study was to examine changes in affect over a relatively short time period in relation to work demands, work activities, and computer and general work (non-computer) hassles. Questionnaire measures of workstation dissatisfaction, usability, two-week retrospective symptoms and affect, and environmental disturbances and distractions were also taken. Because of the homogeneous nature of the sample, a group, as opposed to nomothetic approach was taken to the development of hassles checklists. Open response hassle diaries were used for a number of weeks in order to generate items for checklists. The diary measures included pre and post-session affect (depression, anxiety, fatigue, and annoyance), symptoms (physical and cognitive), computer and general work hassles, and work activities and work characteristics (workload, support, and control). In general the questionnaire measures seemed to be unrelated in any systematic way to the mean scores on diary variables. Following standardization of the diary variables to remove effects of individual differences and pooling the data, it was found that after controlling for levels of pre-work session affect only level of control and work hassles were associated with post-session affect, and no diary measures were associated with symptoms.

The third study also used a diary method, but here, the measurement time period was a day rather than a work session. Assessments were made each day for up to eight weeks. The 122 participants who were computer users and who completed diaries for at least seven weeks were used in the analysis. The aims of this study were similar to those of the previous study, but the increased sample size allowed for more between person analyses, and therefore for additional methods to be used. The diary included measures of affect (depression, anxiety, fatigue, and involvement) and symptoms (cognitive, vitality, and musculo-skeletal), work characteristics (cognitive, emotional and physical demands, personal control and support) work hassles, and non-work hassles. A questionnaire was also used to gather information about the type of hardware and software used, distractions, workstation dissatisfaction, usability, attitudes towards the computer, and symptoms reported as experienced while using the computer. More significant associations between the questionnaire measures and the mean scores on the diary measures were found here than in the previous study, but the pattern of results obtained was difficult to interpret. Few differences were found between those days when the computer was used more or less than the intraindividual mean. Cluster analysis was used to group participants on the basis of the hardware and software they used. There were no differences between these groups on their scores on the affect or symptom measures. Intraindividual correlations were computed between time spent using the computer and the affect and symptom measures, but these showed few associations with the mean diary measures or questionnaire measures. The diary measures were then standardized to remove the effects of individual differences, the day of the week, and the week of the study, and then pooled. After controlling for the effects of the previous day's level of affect, and all other diary variables, higher levels of computer usage were found to have few associations with affect measures, with the exception of lower levels of anxiety and higher levels of involvement. No associations between computer use and symptom measures were found. Work and non-work hassles were found to be most consistently associated with affect and symptom measures.

7.1.2 <u>Possible effects of computer use</u>

Although few associations were found, this section will discuss these associations in terms of the broader possible effects of computer use, and the extent and degree of these effects in the samples studied. From the first study these effects were difficult to determine. This was partly a result of the cross-sectional methodology, as it makes it more difficult to examine why particular responses are made. It was also partly because computer use, in terms of time spent using the computer, or activities undertaken while using a computer, was unrelated to the measures of computer symptoms. Those variables which were associated with computer symptoms were mainly attitudinal, and were not in themselves particularly associated with activities undertaken while using a computer. It was suggested that a general negative orientation towards computer work may be responsible for this pattern of results.

The level of symptoms reported as experienced while using the computer was, for the majority of this sample (68%), either the same or less than the level they reported as experienced generally at work. For this sample, who reported that they used the computer for an average of 36% of their total work time, there were no widespread effects of using a computer on symptom measures.

In the second study, which used diary methodology over a work session, regression analyses showed no relationships between time spent using the computer and affect or symptoms. There were no differences in symptom or affect scores between sessions where the computer was used either less or more than the intraindividual mean. Measures of both work hassles and computer hassles were used, and while work hassles were strongly associated with all affect and symptom measures, computer hassles were associated with none of these measures. The mean value given to work hassles was greater than the mean value given to computer hassles. In correlational analyses of standardized diary variables, computer hassles were associated with higher levels of post-session depression, anxiety, and annoyance. As indicated above, these associations were not present in regression analyses when controlling for the influence of other variables. For this group, who reported that they used the computer for about two hour per day (approximately 24% of their working day) few effects of using the computer, or problems experienced while using the computer were found.

The third study found some possible effects of computer use. In the regression analyses, small but significant associations were found between using the computer and lower levels of anxiety and higher levels of involvement when controlling for all other diary variables and the lag of the affect or symptom measure. No effects of computer use on other affect or symptom measures were found in these analyses. As discussed above, it may be the case that computer use operates partly through increasing cognitive demands which were found here to be similarly associated with lower levels of anxiety and higher levels of involvement. These effects of computer use on affect were apparent in regression analyses where the data were pooled. An examination of intraindividual correlations between computer use and affect and symptoms showed diverse and non-uniform associations. For some people in this sample, correlations were positive, and for others they were negative, and for most these associations were quite weak. Neither the mean diary scores or the questionnaire variables were significantly associated in any meaningful way with these intraindividual correlations. The level of computer use the previous day was not associated with affect or symptom measures.

The effects of computer use for this group were varied and generally weak. On days when the computer was used, the participants in this study reported that they used the computer for about two and a half hours per day (about 35% of their working day). If any general trends can be observed in the variety of effects between people in this sample, they are that more use of the computer was associated with lower levels of anxiety and higher levels of involvement. This relationship was also indicated by the canonical correlation analyses.

In these studies, and for these samples, few effects of computer use on affect or symptom reporting were found. The general impression given by much of the literature reviewed in Chapter Four, that using computers is associated with symptom reporting, was not supported by the results.

7.1.3 Isolating the effects of computers on work and its users

As discussed in Chapter Four, one of the difficulties in the investigation of this research topic is to identify the direct and indirect effects of the computer system on users, particularly where the computer is not used intensively. It is likely that these groups studied here are fairly typical of a wide range, if not the majority of computer users, though there is no empirical evidence to support this view. They are certainly more typical of those engaged in computer-supported work than those groups studied in early investigations of VDU use and eyestrain. In those groups, jobs involved intensive computer work, which was often highly repetitive and externally monitored and paced, and were more computer-dependent, than computer-supported.

For most computer users however, the fact that they use a computer in their work does not have any necessary implications for their job, for the characteristics of their job, or for them, as users. In this sense, using a computer is not in itself a meaningful variable or distinctive category. In the case of jobs which involve intensive and dependent computer use, where the computer can strongly influence job characteristics, it is difficult to distinguish those aspects of the job that are determined by some aspect of the computer technology, as distinct from the way in which the computer technology is integrated into the job. Even where the influence of the computer can perhaps be seen, it is unclear whether this arises because of some integral aspect of the technology, or because of some other relatively indirect effect.

For example, the association between computer use and increased cognitive demands may occur as a result of some aspect of the user interface or computer task, whereby interacting with the computer is in itself more demanding. On the other hand, interacting with the computer may be no more cognitively demanding than, say, typewriting, but the potential for processing information and producing output can be increased with a computer. This in turn encourages higher levels of engagement with the task, and the resulting higher level of cognitive demands. Another indirect route to increased cognitive demands may operate through quicker and widened access to information whereby the user will be able, if they so choose, to increase decision-making activity which may be held up by a lack of information. In these cases, of the indirect influence of the computer on cognitive demands, the changes do not result from any demand of interacting with the computer in itself, which would perhaps be emphasized in a human factors/ergonomics approach.

These effects cannot and should not be isolated. Where they are isolated in a laboratory, as is the case in much human-computer interaction research, it is possible to observe some relatively direct effects of some aspects of the technology, such as the interface, but such observations do not easily generalize to users at work. Where these effects are not isolated, in field studies for example, effects of the technology are less easy to observe, and effects that are observed cannot easily be attributed directly to the technology.

This argument raises the question of how research into the effects of new technology can be undertaken if the nature of the technology is likely to be hidden as it becomes absorbed into and shapes the context in which it is placed. The next section will suggest some ways in which this may be done.

7.1.4 Some recommendations and research directions

From the studies conducted here, and elsewhere, negative affect and symptom reporting among those engaged in computer-supported work as a result of using computers does not appear to be a particular problem. Rather than limiting research concerns to the negative influences of the computer on the health of users, and the associated idea of attempting to somehow protect users from the technology, an important shift in focus may be to find ways of using computers to change the characteristics of work, which may in turn enhance health.

The design of computer systems and user interfaces

The range of jobs which use computers, and the ways in which computers are used within those jobs, means that general remarks about design are difficult to make. However, a number of principles can be described.

Design which attempts to enhance work is very different from other kinds of design. Often, functional requirements take precedence over other design features, and functional requirements can be defined quite narrowly. For example, as mechanization of existing procedures. Given that a computer system is likely to change jobs, an important feature of design may be to consciously build features into a system which will enhance certain job characteristics. One such characteristic is controllability. The importance of this characteristic goes beyond the design of the interface, though clearly control over the interaction and the system is important. Controllability must extend to the control of those tasks which the user is required to carry out. Many of these points echo those made by Frese (1987) who also suggests that systems should be designed to optimize complexity, but to reduce complicatedness. Frese suggests that complexity, when it is also controllable, leads to greater involvement with the task.

Other important principles, partly contained within the idea of controllability, are adaptability and flexibility. This refers partly to the user interface, but also to the integration of the system with user, the task, and the task environment. A system may be controllable, in that the user is able to control what the system is capable of doing, but the system is not adaptable or flexible if these capabilities themselves are relatively narrow or rigid. For example, different users are likely to have different preferences in the way they choose to carry out activities, and different task environments may require that the same goal is reached by subtly different routes.

A useful framework for thinking about such issues can be found in action theory. The importance given in action theory to goal-directed behaviour and the idea of hierarchies of goals provides a way of conceptualizing how controllability, complexity, adaptability, and flexibility may influence the user's affective experience. Such a framework, which would have to incorporate a much broader conceptualization of a user and their goals, could perhaps be included in the design process.

Ways of examining the effects of system/interface design and computer use on work and users

Some of the methodologies used in these studies, particularly the use of computer hassles checklists which are generated by participants, provide useful ways of examining how in actual episodes of computer use, difficulties are experienced. In addition to hassles, computer uplifts, or instances where the computer helped to facilitate the meeting of some goal could be recorded.

Diaries, such as those used here in which changes in affect and work activities are recorded would enable the effects of computer use to be examined more closely. It is likely that cross-sectional questionnaires would be relatively uninformative about these issues, but may be provide useful indications of the secondary effects of a computer system on other areas of work.

Future directions

As indicated earlier, research into the effects of computers has tended to focus largely on the negative consequences of these technologies for the user. In this way, researchers have adopted the role of protector, preventing users from being harmed by the technology. Although negative effects have been found, the concentration of research in this area has precluded a detailed understanding of the way in which computers are used at work, and in particular, how they may increase satisfaction and involvement with the work process.

Further insight into the ways in which computers are used at work will only be gained if the benefits of using systems, as well as the costs, are examined. For example, specific knowledge of the circumstances in which the use of a computer facilitates task completion, and increases cognitive demands and involvement, is likely to be considerably more informative than attempting to establish whether or not computer users report symptoms, or if they are dissatisfied or not with the computer system they use.

7.2 Methodology

This section will focus mainly on the merits and problems of the methodologies used in the two diary studies reported in the thesis, though a brief discussion of questionnaire versus diary methods will take place first. Emphasis will be placed on the methodologies themselves, rather than how they relate to the theory presented earlier in the thesis. Relationships between methodology and theory will be discussed in the next section of this chapter.

7.2.1 Questionnaire versus diary methods

Clearly a direct comparison between these types of methodology cannot be made on the basis of the studies reported here.. The samples, the measures used, and the specific questions asked in the first cross-sectional questionnaire study and the two preceding diary studies are sufficiently different to preclude such a possibility. However, some general comments, supported by examples from these studies, about the relative value of these methodologies will be made.

The first point is concerned with the difficulties of interpreting cross-sectional questionnaire reports of the kind collected in the first study. As discussed elsewhere in this thesis dispositions such as negative affectivity, or even the experience of acute negative affect while a questionnaire is being completed, may inflate associations between reports of work or environmental characteristics and symptoms. This can potentially be controlled for by including a measure which is assumed to tap such a disposition or state. Whether the measure does tap such a disposition, or indeed can account for differences in reporting work or environmental characteristics and symptoms is a question which cannot easily be answered using cross-sectional questionnaire methodology. In addition, there may be good reasons for not controlling for such an effect, as those who experience negative affective states may not simply be displaying perceptual bias in their reporting, but may actually be more reactive to work and environmental characteristics. Using a diary method, and controlling for individual differences by using standardized scores based on intraindividual means solves some of these difficulties, and also controls for other potential inflators or deflators of relationship, such as the possibility of a disposition such as positive affectivity.

A second point concerns the accuracy of questionnaire methods. In both of the diary studies reported here, questionnaire measures were not associated in a meaningful way with the mean scores on diary measures, suggesting that cross-sectional questionnaires may not reflect daily experiences. This view was supported in the studies by the differences in the number of hours per day computer usage reported in the questionnaire, and the number of hours usage reported in the diaries. In both studies, participants reported a higher level of daily usage in the questionnaire than recorded in the diaries.

A number of research topics could ideally be investigated by some combination of prospective questionnaire methodology combined with diary methods, which could for example be used as a probe, or to assess daily fluctuations around a specific event. This combination of methods has been used recently by Bolger (1990) to examine coping over an exam period.

7.2.2 Temporal issues in diary methods

The use of diary methods raises a number of issues concerning the timing of measurements. In the studies reported here, most diary entries, with the exception of affect in the first diary study, were made retrospectively and all at the same point. The main reason for doing this is to reduce demands on the participants. Unless changes in perception over time are specifically being examined, it is perhaps preferable that events are reported and environmental characteristics rated as closely as possible to their occurrence and/or initial perception. In the second study for example, more accurate participant recall and hence measurement of work hassles, and work characteristics would have been possible if participants made entries in the diaries twice; one after work, in order to rate work activities and characteristics and work hassles, and once at the end of the day to rate non-work hassles and daily affect and symptoms. The use of methodological improvements which may reduce demands on participants and permit other patterns of data collection will be discussed in section 7.2.4 below.

Despite the greater flexibility in the timing of measurements which may be offered by these methodological improvements, issues remain about when certain kinds of variable should be measured, and the effects of proximal and distal reporting.

When to measure what

The variables measured in these diary studies exhibited varying degrees of stability and lability, and are probably differentially affected by recall bias and forgetting. Such differences should be taken into account in the design of diary studies, particularly if the demands made on participants can be reduced. The implication of each of these for when particular variables should be measured will be briefly discussed.

If it is known that particular kinds of variables are relatively stable then the number of points at which these variables could be reduced. The reverse is true for more labile variables. Measurement points could also be reduced for those variables less affected by recall or forgetting.

Effects of proximal and distal reporting

Even if it were possible to measure current affect every five minutes, and all hassles as they occurred, for example, it is not clear whether such detail is either necessary or desirable. The frequent recording of these variables is likely to influence the way participants come to interpret and understand themselves and their environment. Also, while such proximal reports would lead to an increase in the strength of association between, say, affect and hassles, it may be that the more long term implications or carry over effects of hassles are more important for adaptational processes.

Although not measured in these studies, perceptions of daily characteristics and events several days or even weeks after they occurred may be equally revealing, but in a different way, and for some purposes such as assessing particular adaptive processes, than perceptions of events on the day they occurred. In short, consideration should be given to the proximity of the reporting of different categories of variables.

7.2.3 Differentiating between dimensions of constructs

A number of the constructs measured in these studies have been assessed elsewhere as constructs with single dimensions, such as mood, quantitative workload, or hassles. Significant differences between dimensions of these constructs, such as depression and anxiety, or emotional and physical demands, were found in these studies. This has implications for the measurement of these constructs in general, but also, more specifically for their measurement in diary studies.

It is likely that some of the distinctions made in these studies could be further refined, but some of the distinctions made result in conceptual overlap. For example, in the second diary study, there was a degree of conceptual overlap between the affect measure of fatigue, and the symptom measure of vitality symptoms. However, further distinctions, for example, between different kinds of hassle within a theoretical framework of adaptive action control could prove useful.

7.2.4 Methodological improvements

The methodology used in the diary studies presented here is relatively new, and has not been subjected to methodological scrutiny elsewhere, even though diary techniques are becoming more common. This section then will sketch out some of the possibilities for making these methodologies more reliable and valid.

Other recording techniques

One of the major difficulties is the load that is placed on the participants, and the relationship between the researcher and the researched is of central importance if reliable data of this kind are to be collected. Much of the load results simply with the time required to give information regularly and frequently. However, the physical and cognitive demands involved in giving such information also arises here because a pencil and paper method is used, and participants have to remember to complete the diaries.

The use of other technologies may help to reduce participant load. Pagers or phone calls could be used to remind participants to complete the diary. In the case of phone calls, participants could be provided with portable phones, and the data could be collected over the phone by asking the participant a series of questions. In this case there would be no demand on the participant to record anything. Questioning and answering on the phone could be more automated, through the use of answering machines, and the distinct tones produced by different phone keys. Portable electronic personal organisers, which have screens and small keyboards could also be used. On some of these the screens are large enough to present rating scales. As the participant gives their rating the data can be automatically stored for later downloading. Most of these organisers can also be programmed to give an auditory signal, which would act as a reminder.

The problem of common method variance

The fact that all these ratings are self-report brings with it the problem of common method variance (e.g. see Glick et al, 1986; Spector, 1987), and the possibility that relationships between variables are inflated. Any other sources of measurement help to lessen this difficulty.

Observations and ratings by work colleagues or family members to an extent remove some of these problems, however, the use of other, more quantitative measures is also desirable. In the case of workload for example, it would also be useful to know how much work was completed, as well as perceptions of that work. Kirmeyer (1988) for example observed the work of police radio dispatchers in order to make an objective assessment of their workload.

Physiological monitoring could provide another source of information. Unobtrusive measures can be obtained in a number of ways. Heart rate, for example, can be recorded on a magnetic audio tape, carried in a small personal tape recorder by the participant. Telemetric monitoring, where a radio signal containing information from the monitors is transmitted by a device worn by the participant is also possible. As instruments for measuring physiological phenomena become more portable and usable, their use is likely to increase, though, as indicated earlier, problems of interpretation will remain.

Measures

The measures used in these studies were a development on those more commonly used in diary studies. Affect, workload, and symptoms were sufficiently detailed to observe different patterns of interactions. However a number of further improvements could be made.

In the first diary study, a computer hassles measure was developed by first collecting examples of hassles in free form diaries, and then collating and sorting these examples into a representative checklist. This principle could be extended to other kinds of hassles checklists. Also, idiographic hassles checklists could be developed where all the hassles on it were generated by the participant themselves. Some hassles on checklists could either never apply to participants, or may happen never to apply, yet this does not mean that they are not experiencing hassles. Idiographic measures of symptoms could also, for the same reasons, be used: In repeated measurements and intraindividual analyses no information is gained by taking any measure which does not vary.

A second way in which these measures may be improved is to increase the use of self-anchored rating scales. The anchors 'not at all/very much' may not allow the participant to fully use the scale. In the instructions it could be made clear that 'not at all' means the least that the participant has ever experienced, rather than zero, while the anchor 'very much' means the most the participant has ever experienced, rather than some general extreme. In the case of most of the rating scales used in the diaries, this would allow more variance, if it was there, to be assessed.

Finally, the conceptual overlap between some of these measures, while it is in part inevitable, could be reduced as much as possible. For example, the affect measure of fatigue and measure of vitality symptoms used in the third study should in future be made more distinctive.

Training

In the second diary study, there were no checks that the participants fully understood the instructions, though they were offered help if they wanted to accept it. In the first diary study, personal contact was made with each participant individually before the study. In general, talking with participants in order to answer questions, and making regular checks on the accuracy of recording during a training period would improve the quality of the data and resolve any problems the participants may have with the diaries. As indicated above, these sessions are particularly important for developing a working relationship with the participant.

7.3 Present and future implications for the theoretical framework of adaptive action control

In Chapter Three, a number of aspects of the theoretical framework of adaptive action control (TAAC) were discussed. In this section, some of the broad implications of the findings and the methodologies for the TAAC will first be discussed. Next, some possible future developments of the TAAC will be considered, and finally, its limitations will be outlined.

7.3.1 Indirect support for the TAAC

It was not the intention in conducting the studies in this thesis to directly test propositions generated by the framework. Nor was it the intention in developing the framework and the other theoretical work presented here that they should be empirically tested in the usual way. First, it is not possible or even desirable to comprehensively test such a broad framework using empirical techniques. Second, the soundness or value of the theory does not depend solely on the empirical support that can be found for it.

As stated earlier in this chapter, the purpose of the empirical work, in addition to answering questions about the research topic, was to explore a small part of the framework by using methodologies derived from it in empirical work. The consequences of using the methodologies can then be fed back into the theory, so offering indirect support or disconfirmation, suggesting where the theory is plausible, and highlighting inconsistencies or incoherences. There are many ways to explore the soundness and value of theory. One of the central reasons for choosing methodology as the main route here was the lack of adequate methodology in stress research as a whole, and the lack of correspondence between existing methodologies and theories.

Relationships between methodology and theory

The methodologies were used to examine a research topic which was applied, specific, largely unexplored, and described on a general level. Much of the theory however was expressed on a quite a detailed, and relatively pure (as opposed to applied) level, for example, specifying how different levels of goal hierarchies may be interconnected, or describing the relationships between goal-directed behaviour and affect. The relationship between methodology and theory in this instance cannot therefore be particularly close in terms of their level of description or explanation.

Different parts of the theory would require evaluation though the use of different methodologies on different levels. For example, the interconnection of different goal hierarchies could be accessed through intensive interviewing and observational techniques over a number of years, while the relationships between goal-directed behaviour and affect could be explored via laboratory experiments, or through the analysis of clinical material which may be derived from psychotherapy. Some form of intensive clinical interviewing based on examining the relationships between cognition, the source of cognitions, such as goals, and emotions and actions could also be used. This may involve techniques derived from cognitive behavioural (e.g. Beck, 1976), or rational emotive (e.g. Ellis, 1973) therapies.

The use of diary methodologies and measures of hassles and affect represent a stage in between the crude level on which measuring life events and illness are measured, and the very detailed and intensive levels of clinical interviews described above. It is likely that both these more detailed levels will be necessary to examine similarities and differences in the patterns of relationships which can be observed on different levels.

Examples of indirect support

A consistent finding across both studies which used diary methodology was the strong association between hassles, which in these studies were conceptualized as events or situations which make goals more difficult or impossible to meet, and measures of affect. In the theory presented in Chapter Three it was suggested that failure to reach goals, or threats to goals, would influence affective states.

It was also suggested there that different kinds of hassles, depending for example on the extent to which they were associated loss or threat, would be associated with changes in different dimensions of affect. Although not directly examined in these studies, hassles from different sources produced different effects. In the first study, although work hassles were strongly associated with affect, computer hassles were not. In the second study, work and non-work hassles were associated with affect, but displayed different patterns of relationships. Anxiety was more strongly associated with work hassles, and depression with non-work hassles. Although more information would be required for a full interpretation to be made, it is clear that different hassles, in different areas of activity are associated with different patterns of affective response, and the TAAC can partly account for these differences. Interpreting the types of goals involved in these areas, and their places in a hierarchy go some of the way to explaining these findings. Problems experienced in attempting to meet goals at work are more likely to cause anxiety as they are connected with threats to the attainment of future goals and the completion of tasks, which will produce anxiety and worry, and a threat of failure, rather than a sense of loss. Problems experienced outside work however are more likely to be connected with relationships which exist already, and the goals concerned with the maintenance of states. Problems in maintaining such goals, particularly where they involve relationships, are likely to involve feelings of potential loss, sadness, and depression.

This latter finding, demonstrating the differences between work and non-work hassles, also supports the theoretical impetus behind the differentiation between dimensions of constructs such as affect. Such information would have been lost if a general measure of positive mood had been used. Differentiating between different kinds of demands also revealed quite different patterns of relationships which would have been hidden by a general unidimensional measure. In the second study, cognitive demands were associated with lower levels of depression, but emotional demands were positively related. A further example from the same study was that while there was no significant relationship between cognitive demands and anxiety, one did exist between emotional demands and anxiety. Such findings support the need for methodological and conceptual separation and sophistication of constructs, a sophistication often absent in stress research.

Differentiation was also emphasised in relation to systems in the theory presented in Chapter Three. It was noted that while distinctions between and definitions of systems are difficult, much stress research tends to use non-specific measures of health, regarding psychological and physical health, because they may be mutually influencing, as some general system. This as has already been discussed, is not justifiable even within what can be regarded as a single system, such as affect. The findings of these studies do not support the notion of a general system of health. Comparing affect and symptom measures in both studies, it is clear that affective states are more influenced by hassles, job activities and characteristics than are symptom measures. In both studies more variance in affect measures than symptom measures was accounted for by diary measures.

Perhaps the clearest example of evidence against the idea of a general system of health, which also shows the benefits of differentiation in measurement, and the opportunities created by using these methodologies, was found in the results from the canonical correlation analyses presented in Chapter Six. Two quite distinct and independent patterns of affect, were shown to be related to distinct patterns of work variables. This also offers evidence against the idea of a general system of environmental variables, such as high workload and low controllability, having negative effects on affect or symptoms. It was shown in these analyses that it is the particular combination or pattern of a number of these environmental variables which is associated with changes in affect or symptoms. These examples give broad support to the methodology used in these studies, which in turn supports the theoretical framework from which these methodologies were derived.

7.3.2 Further development of the TAAC

Development of the theoretical framework can take place in a number of ways, for example through the use of empirical work, through rational methods, or through both. Arguments can be made in favour of any method or set of methods. It is likely that the nature of the specific part of the framework under examination, and the resources and tools available will have a central influence on the methods used. Rather than discuss how such development may take place, this section will discuss the two major aims of further development, and some ways in which methodologies can support such developments.

Integration of psychological constructs

In Chapter Three the parts of this integrative process were outlined. Interrelationships between general psychological constructs such as motivation, affect, and control were described. However, further specification of the interrelationships between other psychological constructs is necessary if the theoretical framework is to be comprehensive. Examples of other constructs which perhaps could, and certainly should be included are many and various; psychoanalytic ideas, such as the unconscious, social psychological concepts such as interpersonal attraction, attributions, and other interpersonal behaviours, and cognitive constructs such as memory, intentions, and attention, and psychophysiologial phenomena, like arousal and physiological adaptation.

The relationships between these constructs is in some ways difficult to see, and if in practice links are difficult to make, then they should not be pushed together for the sake of unity. A theoretical framework can be integrative without forcing all psychological phenomena into the same mould. Indeed the fact that some of these phenomena may not be easily related would inform the development of theory.

Integration of levels of behaviour

A closely related aim of further development of the theoretical framework is to increase our understanding of behaviours which occur at different levels and within different time scales, and to provide a more comprehensive picture of human activity and the unity of many human actions. The boundaries which exist, say, between psychological phenomena which occur on the level of milliseconds and those which occur over weeks, are artificially maintained by the push of analytic scientific research towards narrow specialization.

Such an effort will require that the psychological systems which may exist, and equally importantly, the links between them, are specified more clearly. While it is inevitable that any picture of complex behaviour will be limited, current practices, particularly in stress research, seem to preclude the possibility of making our knowledge more sophisticated. These practices also artificially separate and make distinctions between phenomena which on other levels cannot be separated. In order to move towards the attainment of either of these aims, methodologies will have to be developed, or existing methodologies used in new combinations.

Development of methodologies

Suggestions about ways of improving and refining the diary methodologies used in the studies in this thesis have already been made above. Here, the concern is with the broader development of methodologies and design in order to more fully explore the theoretical framework presented in Chapter Three. The most general way of describing the possible developments is that they would need to be longitudinal, multi-method, and be used in the context of examining within-person variation to search for robust generalizable but varied patterns of adaptation, development and health, rather than searching for cross-sectional, between-person variation which leads to relatively crude generalizations.

To gain even a partial understanding of the process of adaptation in one individual and their environments, the systems involved, and the kind of control mechanisms which are operating, the quantity of information which would need to be gathered from one person would be extremely large. The aim would not be to understand as much as possible about a few individuals over as long a period of time as possible, although this may actually give considerable insight. Rather it would record as fully as possible and in a consistent manner across situations and levels, the actions, goals, and states, which can describe a person at that particular time or within that particular time frame, and on that particular level. These data could then be compared with data from other levels more easily, hence enabling possible links to be found. In addition, only through such methods can changes over long time periods in patterns of adaptation, rather than simply changes in levels of variables, be observed.

The use of a variety of methods is important as activity in different systems can only be accessed through different methods. Many techniques could be

7.3.3 Limitations of the TAAC

Some of the limitations of the theory presented in this thesis, that much of it is expressed on the level of analogy, and that it is too large to be easily examined, have already been discussed in Chapter Three. In order to clarify these and other limitations, a notion of what a theory is for, or what a theory should do is required. The Popperian ideal of scientific progress (Popper, 1959), in which science proceeds by generating a series of simple, testable, and disconfirmable theories is not shared here. The TAAC is, on the whole, not simple, testable, or disconfirmable. In these terms then, the theory is limited because it is over-inclusive and over-general. In some particular areas of scientific inquiry such a Popperian approach may be productive, but in the case of stress research, it is unlikely that such a procedure could work. This issue will be discussed further in the next section.

While there are certainly other difficulties with the theoretical framework, its limitations are somewhat difficult to identify as the broadness of the framework has meant that relatively few parts of it could be presented here in a detailed way. In addition, it is the case that the limitations of theory often only become apparent through use. One of the aims of this framework was to be integrative and generative, pulling together different strands of theory and generating directions for further research. While this can be viewed as a strength of the framework, it can also be viewed as a limitation; the theory cannot be disproved, and interpretations may become constrained by the framework.

However, there is strong evidence from the empirical work which supports the view that in stress research the low level of sophistication in the measurement of variables and the theories which attempt to explain relationships between variables over-simplifies and misrepresents the phenomena under examination. In this context, the function of theory is very different from its function in other areas of research. While in the future, specific theories from the TAAC could be tested more directly, the development of this framework was to present an initial structure in which theories could be generated. This initial structure has only been partly developed here.

7.4 The future of stress research

The futures of several areas of research have already been discussed in this chapter: research into affect and symptom reporting in computer-supported work; research which refines and builds upon the methodological techniques used here; and research directed at the development of the theoretical framework. This thesis started with the history of stress research, and a detailed examination of the variables used in stress research. This thesis ends where it started, with a discussion of stress research. But here it will be the future, rather than the past history of stress research which will be discussed.

7.4.1 The redundancy of the stress concept

However the stress concept is defined and described, as a stimulus, a response, an interaction, a transaction, or as a rubric for an area of study, the continuing use of the concept and the term itself at best contributes little or nothing to the development of understanding of the ways in which environmental, social, psychological and health phenomena are associated, and at worst makes these developments more difficult to obtain.

All the phenomena surrounding the stress concept, or included under the rubric of stress, possess a complexity which cannot be expressed or contained within it. As discussed in Chapter Three, the most important function of the idea of stress is as a modern myth, used by researchers and the public in a mutually reinforcing way. This myth is only the latest in a series, such as bodily humours or miasmas, that over centuries have served as explanations of disease. Within the modern context and the domination of science, stress, with its physical/engineering connotations can be seen to be particularly appealing. It is perhaps unusual as a myth, in that the scientific understanding and use of the concept is barely greater than or any different from the public understanding and use of the concept.

The popularity of stress is evident in news and current affairs programmes, in the large number of self-help books available, in the growing popularity of stress-management courses, in fiction, and even on humorous presents, such as cards, badges, and mugs found in gift shops. It is this very popularity which at the same time both helps researchers, in terms of funding, and providing a rationale, yet it also hinders the researcher in that it narrows their focus onto studying ill-health, and onto simple mechanistic causal explanations.

7.4.2 New kinds of questions with difficult answers

Moving away from the stress concept also means changing the kinds of questions we ask, and the kind of answers we can expect. Although the concept may be rejected, what were referred to earlier as stress phenomena are not, even though they are inadequately conceptualized and measured. Indeed, the inadequate conceptualization of these phenomena is largely the result of the predominance of the stress concept. Stress phenomena, such as affect, subjective well-being, coping, characteristics of the environment, and dispositions are a fundamental part of human experience and they, and the relationships between them, remain of central importance in psychology.

The kinds of questions which are currently asked are driven by a medical model of health, and their concern is to establish relationships between psychological variables and health variables. Certainly those variables which are seen to protect health, or buffer it from harmful psychological phenomena are also studied, but only inasmuch as they are seen to increase or decrease levels of health. The answers produced by these questions do not, and inevitably cannot inform us about stress phenomena. We discover that some people report low levels of subjective well-being, others do not, and that other variables partly predict the level of subjective well-being experienced.

Such findings remain unhelpful as they tell us nothing about processes, and nothing about the subtle patterns of interaction that occur between such variables. Despite the public popularity of the stress concept, it is accepted that the reasons why an individual at any point in time experiences low or high levels of well-being are extremely complex. In the case of low levels of well-being for example, a huge range of combinatory explanations could be offered: They always feel negative; they are still feeling weak after an illness; their partner has recently left them; they are worried about a future event; they haven't got any money; they feel they have too much to do; things aren't going well at work; there is a family conflict; they aren't looking after themselves; they need a good rest; they are ill; nothing seems to be going right for them; and so on.

What is generally known then, is that a large number of phenomena interact together in unclear and complex ways to produce individual levels of subjective well-being. Simply asking what determines and/or protects well-being is not the kind of question which can make the interactions between these phenomena any clearer. The kinds of questions which might are those which set out to inquire about the nature of these phenomena, rather than to demonstrate relationships. The answers to these questions will therefore not provide us with any easily digested information. They will not fit neatly with particular models of scientific progress, such as theory testing or fact finding. In the case of stress phenomena, it has repeatedly been demonstrated that the theories that can easily be tested are probably not worth testing, and the facts that can easily be discovered and digested are certainly trivial.

7.4.3 Searching for patterns in chaotic systems

In Chapter Three, chaotic systems were briefly described. Parallels were drawn between the requirements for a theory of weather, as a typical chaotic system, and the requirements for a theory of stress phenomena. In such systems, determinism, or cause and effect, may operate in some circumstances and for some periods, but in others, the behaviour becomes unpredictable. Often, these periods themselves seem to repeat, producing predictable periods of unpredictable activity. What is often seen as noise or interference in a system is embraced within chaos theory as part of the phenomena under examination.

These repeating, interwoven, and interspaced patterns of change, over different time periods are perhaps the nearest model that exists for the patterns of variation that may exist in stress phenomena. Such variation can be seen within people. Different kinds of variation can be seen between people. In order to understand more fully the complex system which incorporates stress phenomena, careful and repeated observations are required, as is a large amount of data from as many sources as possible. In learning how to predict the weather, no static relationships are demonstrated, and there are no findings, as such. Rather, what needs to be understood, amongst other things, is the pattern of relationships between variables, how this pattern changes over time, and exactly when the weather can and when it cannot be predicted.

Such an approach has a vast number of implications for methodology, for the way research is conducted, and the rationale that is provided for the research. More importantly though, it means changing our expectations of what research is for, and what we hope to find.

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APPENDICES

Appendix A1.1 contains a copy of the Diary of Computer Hassles and Work Hassles used during Stage One of the study reported in Chapter Five. The instructions to participants are given at the start of the diary booklet. This is followed by a completed example given to participants, and a blank page of the Diary. The Diary contained enough pages for four weeks entries.

Appendix A1.2 contains a copy of the instructions for the Stage Two Daily Diary Booklet given to participants and a complete copy of the Daily Diary Booklet used in the study reported in Chapter Five.

Appendix A2.1 contains the covering letter and instructions sent out with the first of eight Weekly Diary Booklets. These materials and those in the next Appendix were used in the study reported in Chapter Six.

Appendix A2.2 contains specific sections of the Weekly Diary Booklet. A copy of the front cover has been included, which folded out to display the three pages of instructions which follow. At the end of this Appendix are the blank pages for making entries for one day, though the Booklet contained pages for Monday through to Sunday.

APPENDIX A1.1

Stage One Diary of Computer Hassles and Work Hassles

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A Study of Computers, Work Effectiveness and Psychological Well-Being

STAGE 1 DIARY OF COMPUTER HASSLES AND WORK HASSLES

As oulined in the Research Proposal which was distributed some time ago, Stage 1 of the study involves completing a daily diary at the end of each working day over a period of four weeks. It should take you approximately five minutes a day to complete.

The instructions start on the next page of this booklet. If you have any problems completing this diary, or any general queries, then please contact me at the above address/telephone number.

All the information you give will be treated in the strictest confidence and will be seen only by me.

INSTRUCTIONS

These instructions are divided into two sections. The first section gives a general description of how to keep the diaries, and explains the meanings of some of the words used. The second section is a step-by-step guide to keeping the diary. It may seem a little complicated at first, but it will soon become clear.

Section One

This diary is designed to collect descriptions of the day-to-day hassles you experience at work when you are using the computer, and more generally at work when you are not using the computer. The information you give at this stage will be used to create checklists of computer and work hassles for use in stage 2 of the study. The diary covers a period of four weeks, or twenty working days.

What is a hassle? A hassle is any event, thought or situation which makes you aware that your goals and plans will be more difficult or impossible to achieve. Such hassles are accompanied by negative feelings such as annoyance, irritation, worry or frustration. Hassles tend to occur very frequently, and the negative feelings associated with them may last for quite a short time. Below are some examples of computer hassles and work hassles. These are only examples, and you can probably think of many more. When you are keeping the diaries, it is important to write down those hassles which you personally found to be annoying or frustrating during the day.

Examples of computer hassles:
- The printer malfunctioning
- System response time too slow
- Making an error which loses work on a disk
- Having to repeat the same command when there could be a short-cut
- Being interrupted while entering a long sequence of commands
- Finding the system difficult to use
- Not being able to do what you want with the system

Examples of work hassles:
- Difficulties with work colleagues
- Not being able to contact someone urgently
- Interruptions while you are trying to concentrate
- Having too many conflicting demands
- Having to deal with urgent demands
- Not having all the information you need to carry out a task

In the diary you will be asked to write down four computer hassles and four work hassles at the end of each working day. It is of course possible that you have not used the computer that day, if so then please write N/A in that section. In order to make it easier for you to recall the hassles it may help if you go through your day, perhaps using your diary, and think about those things that hindered you while you were working. It may also help if you make a short note of any hassles you experience as you go through the day.

After writing down a hassle, the diary then asks you about the feelings associated with that hassle. In this section you will be presented with a number of words which describe feelings, you are asked to circle all the words which describe how you were feeling as a result of the hassle. Your feelings will depend on many things including the nature of the problem, what you do about it, and so on.

Then for each hassle you will be asked about what you think the causes of the hassle were. In the case of computer hassles for example, the cause may be a machine malfunction, or inadequate software. It is important that you write down what you personally think were the causes of the hassle.

Section Two

This diary has twenty pages for you to record hassles on twenty days. What follows now is a step-by-step guide to completing the diary. It may help if you refer to the completed sample on the next page.

1. Start keeping the diary on a Monday. If you happen to be absent from work on any day during the four week period then write 'absent' on the diary page.

2. Complete the diary at the end of each working day. It may be helpful if at the start of the four week period you put a note in your work diary for each of the days you will be completing the diary to remind you to complete it at the end of each day. Also, as suggested above, it may be easier to recall the day's events if you look in your own work diary, and make short notes of them during the day as they occur.

3. The diary asks first about your computer hassles. Please try to think of four. When you are writing these down please give enough information to make it clear what actually happened.

4. Write down one computer hassle at a time. THEN

   4a. When you have described a computer hassle, try and recall how you felt at the time. Then circle all the words which describe how you felt at the time. You may circle as many as you wish.

   4b. For that computer hassle, write down what you personally think were the causes of that hassle.

   4c. Then recall another computer hassle, and repeat the above procedure for each computer hassle.

5. The diary now asks about your work hassles. Please repeat the same procedure used for the computer hassles.

FOR FURTHER CLARIFICATION SEE COMPLETED SAMPLE ON NEXT PAGE

DAILY DIARY OF COMPUTER HASSLES AND WORK HASSLES (SAMPLE)

SAMPLE DAY 17 JAN (please enter date) TIME 4:45pm (please enter time)

NOTE: Please remember to write down one hassle at a time. Then circle any of the words that describe feelings which were associated with the hassle. Please circle all those that apply. Then write down what you think were the causes of the hassle

COMPUTER HASSLES	FEELINGS ASSOCIATED?	CAUSES?
1. Printed out long document and forgot to change margins. Had to print it out again	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	My memory!
2. Typed in long document, did not save before network crashed	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	Computer system, partly my fault for not saving as I went along.
3. Couldn't get the system to copy a file. Eventually found out how to do it. Took a long time	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	My fault, could have looked in manual
4. Trying to type in long sequence of commands, phone kept ringing and I had to start again several times	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	No cause / other people
WORK HASSLES	**FEELINGS ASSOCIATED?**	**CAUSES?**
1. Asked to finish a report for next day. Thought I had a week to finish it.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	Person who gave me incorrect information in first place
2. Had an argument with work colleague about the best way to do a particular job.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	Colleague being inflexible
3. Tried to get in touch urgently with someone by telephone. Constantly engaged.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	No cause, but could have contacted sooner
4. Couldn't get anything done as I was waiting for a report which a colleague had mislaid.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	Colleague who always loses things.

DAILY DIARY OF COMPUTER HASSLES AND WORK HASSLES

MONDAY........................(please enter date) TIME........................(please enter time)

NOTE: Please remember to write down one hassle at a time. Then circle any of the words that describe feelings which were associated with the hassle. Please circle all those that apply. Then write down what you think were the causes of the hassle

COMPUTER HASSLES	FEELINGS ASSOCIATED?	CAUSES?
1.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	
2.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	
3.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	
4.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	
WORK HASSLES	**FEELINGS ASSOCIATED?**	**CAUSES?**
1.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	
2.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	
3.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	
4.	Irritated Worried Tired Gloomy Bored Tense Frustrated Fatigued Miserable	

APPENDIX A1.2

Instructions for the Stage Two Daily Diary Booklet and

The Daily Diary Booklet

A Study of Computers, Work Effectiveness and Psychological Well-Being

STAGE 2 DAILY DIARY BOOKLET

INSTRUCTIONS

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These instructions are divided into two sections. The first deals with general instructions, and the second deals with specific details of the Daily Diary Booklet.

SECTION 1: GENERAL INSTRUCTIONS

This section takes the form of general questions you may be asking about the Daily Diary Booklet, with their answers.

1.1 On what days do I use the Daily Diary Booklet?

As described in the original research proposal, each Daily Diary Booklet is to be used on just one day per week, for six weeks

1.2 How do I decide on which day to use it?

This is up to you, but it must be on a day when you will be working in the office, rather than travelling, or working on other sites. It is advisable to to decide in advance which days on which you will use it, otherwise you may forget.
A good way of doing this is to look through your personal diary and write a reminder to yourself, some weeks in advance that you will use the Daily Diary Booklet on that day of that particular week. For example you could decide now that you will use the Daily Diary Booklet each Wednesday (or nearest possible day) for the next six weeks, and then write six reminders in your personal diary.

1.3 How do I use the Daily Dairy Booklet?

The Daily Diary Booklet is divided into four sections. Each of the sections is designed to be completed at four points in your working day. The first is the morning when you arrive at work, the second just before your lunch break, the third after lunch, and the fourth at the end of your working day.

1.4 How long will it take me to complete the Daily Diary Booklet?

It will take you, in total, approximately ten minutes to complete, though of course it may take a little longer the first time you use it. The Daily Diary Booklet is designed to be quick and easy to fill-in and complete. A number of features contribute towards this. For example, in nearly all the questions you are asked to circle a number between 0 and 8 to indicate your response, rather than writing in an answer, or having to use different response formats.

SECTION 2: DETAILS OF THE DAILY DIARY BOOKLET

This section takes the form of specific questions you may be asking about how to use the Daily Diary Booklet, with their answers. It is helpful if you have a copy of the booklet with you so that you can refer to its contents.

2.1 How is the Daily Diary Booklet organised?
Each section (1 - 4) is ordered in the booklet. During the day you will be work through it in the order in which the sections are presented in the booklet. This is shown in the table below. Please note that sections 1 and 3 are identical, as are sections 2 and 4.

MORNING	PRE-LUNCH	POST-LUNCH	END OF DAY
On arrival at work.	Just before you take lunch.	Just before you start afternoon work.	Just before you leave work.
SECTION 1 (page 1)	**SECTION 2** (page 3)	**SECTION 3** (page 6)	**SECTION 4** (page 7)

The order of the Daily Diary Booklet Sections

2.2 How do I indicate my response to the questions in the Daily Diary Booklet?
Nearly all the reponses you give will invlove placing a circle, or any other clear mark, on a number between 0 and 8 inclusive on each line of numbers. NOTE: With the exception of the questions about hassles (2.5 and 4.5) where you can insted circle N/A (Not Applicable). As in the example below, the scales run 0 to 8 from left to right.

Not at all	0	1	2	3	4	5	6	7	8	Very much

Example of a response scale

When considering where to place your circle (or other mark) remember that you can circle any number from 0 to 8 inclusive, otherwise you may find that you circle the same number each time. In general, lower numbers indicate less of some property or quality asked about in the question, while higher numbers indicate more of some property or quality.

The next questions deal with specific sections of the Daily Diary Booklet in the order in which they appear.

This question refers to sections 1.1, 2.1, 3.1, and 4.1.
2.3 How do I answer the questions about feelings and emotions?
An example of how to fill these in is given in the Daily Diary Booklet in section 1.1 (page 2). In addition, please remember to write down the current time in the space provided at the bottom of each of these pages.

This question refers to sections 2.2 and 4.2.

2.4 **How do I answer the questions about the requirements and demands of my work?**

Please remember, that these items refer to what actually happened during the work period, rather than what you would like to have happened.

These are reasonably self-explanatory. However, some items may need further clarification:

Item 3: How much **support** was available to you?
This means support in terms of getting help and being able to rely on others when you needed it.

Item 4: How much **spare time** did you have?
Spare time in this item means time when you could take it easy for a while and weren't responding to immediate demands.

Item 6: How much **control** did you have over your work?
This means being able to use your disecretion or to be flexible about the way in which tasks could be done.

This question refers to sections 2.3 and 4.3.

2.5 **How do I answer the questions about my time spent on activities?**

The only thing to remember here is that these categories of activity will overlap. So for example you may be using the computer on your own, and then talk to someone for ten minutes. The important thing to remember is that you should try and approximate as best you can.

Category 1 (working with a computer) includes any activity you use the computer for: Word processing, E-Mail, programming and so on.

Category 2 (working with other people) includes any time spent communicating verbally with other people. This may be in meetings, in quite informal conversation, or on the telephone.

Category 3 (working on your own not using a computer) includes reading, just thinking about things, sorting out paperwork and so on.

This question refers to sections 2.4 and 4.4.

2.6 **How do I answer the questions about symptoms and problems?**

These should be self-explanatory.

This question refers to sections 2.5 and 4.5.

2.7 **How do I answer the questions about hassles?**

A definition of hassles is given at the beginning of each section. Also NOTE 1 and NOTE 2 are included to clarify the meanings of the questions.

The best way to answer these is to keep in mind the activities of the work period, otherwise it may be difficult for you to remember the extent to which each item was a hassle for you. Remember that these sections ask you about the extent to which these items were a hassle, not simply whether they occured or not.

THANK-YOU FOR READING THESE INSTRUCTIONS.

IF YOU HAVE ANY FURTHER QUERIES PLEASE CONTACT ME

Your Personal ID Number....................

A Study of Computers, Work Effectiveness and Psychological Well-Being

STAGE 2 DAILY DIARY BOOKLET

PLEASE WRITE DOWN TODAYS DATE..............................

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SECTION 1: To be completed on arrival at work

1.1 Below are listed a number of words that describe feelings and emotions. Please read each word and decide the extent to which each word applies to you **right now, at this present moment.**

GENERAL EXAMPLE: This example applies equally to all the other mood checklists (2.1, 3.1, and 4.1) used in this diary. Look at the example below which uses the word 'Sleepy'. Consider the extent to which you feel sleepy right now, at this present moment. Then, looking at the numbers from 0 to 8, decide which one best represents the extent to which you feel sleepy right now, at this present moment. If for example you feel very sleepy, but not extremely sleepy you would circle number 6 or 7. In the example below, number 7 is circled.

Sleepy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely

Now consider each of the words listed below, and circle whichever number (0-8) best represents the extent to which you feel this way, **right now, at this present moment.**

Please remember to circle one number on each line.

1. Enthusiastic?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
2. Fatigued?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
3. Relaxed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
4. Lively?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
5. Tense?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
6. Irritated?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
7. Calm?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
8. Gloomy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
9. Tired?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
10. Uneasy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
11. Annoyed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
12. Cheerful?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
13. Alert?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
14. Miserable?	Not at all	0	1	2	3	4	5	6	7	8	Extremely

PLEASE WRITE DOWN THE CURRENT TIME....................

SECTION 2: To be completed before your lunch break

2.1 Below are listed a number of words that describe feelings and emotions. Please read each word and decide the extent to which each word applies to you **right now, at this present moment**.
(Please see 1.1 if you require an example)

Please remember to circle one number on each line.

1. Enthusiastic?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
2. Fatigued?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
3. Relaxed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
4. Lively?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
5. Tense?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
6. Irritated?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
7. Calm?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
8. Gloomy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
9. Tired?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
10. Uneasy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
11. Annoyed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
12. Cheerful?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
13. Alert?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
14. Miserable?	Not at all	0	1	2	3	4	5	6	7	8	Extremely

PLEASE WRITE DOWN THE CURRENT TIME....................

2.2 Please think about the requirements and demands of your mornings work, and then rate each of the following scales. Please remember to rate each scale for what **actually happened** during your work this morning.

Please remember to circle one number on each line.

1. How **difficult** did you find your work?	Not difficult	0	1	2	3	4	5	6	7	8	Very difficult
2. How **quickly** did you have to work?	Not quickly	0	1	2	3	4	5	6	7	8	Very quickly
3. How much **support** was available to you?	Not much	0	1	2	3	4	5	6	7	8	Very much
4. How much **spare time** did you have?	Not much	0	1	2	3	4	5	6	7	8	Very much
5. How much did you have to **do**?	Not much	0	1	2	3	4	5	6	7	8	Very much
6. How much **control** did you have over your work?	Not much	0	1	2	3	4	5	6	7	8	Very much
7. How much **mental effort** was needed?	Not much	0	1	2	3	4	5	6	7	8	Very much

2.3 Please write down the approximate number of minutes you spent on each of the following activities during your mornings work. Please note that the total number of minutes should roughly equal the minutes in the morning work period.

1. How long did you spend working with a computer? ....Minutes
2. How long did you spend working with other people? (e.g. in meetings, talking to colleagues) ....Minutes
3. How long did you spend working on your own while **not** using a computer? ....Minutes

2.4 To what extent did you experience any of the following symptoms/problems this morning?

Please remember to circle one number on each line.

Headaches?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Eyestrain?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Backpain?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Difficulty concentrating?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Difficulty making decisions?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Difficulty remembering things?	Not at all	0	1	2	3	4	5	6	7	8	Very much

2.5 Hassles are any events, thoughts or situations which make you aware that your goals and plans will be more difficult or impossible to achieve (either at all, or in the way you would like to achieve them). Such hassles are usually accompanied feelings such as annoyance, irritation, worry or frustration. Hassles occur very frequently and as such, are part of everyday working life. The feelings associated with them may last for quite a short time.

NOTE 1: The hassles (on the next page) are divided into non-computer work hassles and computer work hassles. Try as far as possible to separate out those which occured in connection with your work when you were not using a computer system and those that occured in connection with your work when you were using the computer system.
NOTE 2: Only circle N/A if it would have been impossible for the item to be a hassle for you this morning. For exmple if none of your work colleages was absent this morning (No. 1), or if you didn't use the E-Mail system (Nos. 15 & 17) these items should be circled N/A. Please remember to circle one number or N/A on each line.

2.5 (Continued). To what extent were the following items a hassle for you this morning?

Please remember to circle <u>one</u> number or N/A on <u>each</u> line.

<u>NON-COMPUTER WORK HASSLES</u>												
1. Absent work colleagues?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
2. Expected events not occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
3. Difficulty of tasks?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
4. Dull or monotonous tasks?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
5. Your own ability or knowledge?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
6. Interruptions from others?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
7. Tasks taking a long time?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
8. The type of demands placed on you?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
9. Being uncertain about how to proceed?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
10. Unexpected events occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
11. Realising you have a lot to do?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
12. Conflicts with other people?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
13. Letting other people down?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
14. Bureacracy or red tape?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
<u>COMPUTER WORK HASSLES</u>												
15. Accessing E-Mail?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
16. Exiting from programs/systems?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
17. Transmitting E-Mail?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
18. Bugs in software?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
19. Tasks taking a long time?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
20. Incompatability between systems?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
21. Failure/crash of program/system?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
22. Slow mainframe response time?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
23. Getting required printout?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
24. Your own ability or knowledge?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
25. Expected events not occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
26. Doing tasks the way you want to do them?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
27. Being precise in issuing commands?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
28. Making errors?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
29. System documentation?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
30. Slow printing?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
31. Unexpected events occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A

<u>SECTION 3: To be completed after lunch just before you start your afternoon's work</u>

3.1 Below are listed a number of words that describe feelings and emotions. Please read each word and decide the extent to which each word applies to you **right now, at this present moment**.
(Please see 1.1 if you require an example)

Please remember to circle <u>one</u> number on <u>each</u> line.

1. Enthusiastic?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
2. Fatigued?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
3. Relaxed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
4. Lively?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
5. Tense?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
6. Irritated?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
7. Calm?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
8. Gloomy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
9. Tired?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
10. Uneasy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
11. Annoyed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
12. Cheerful?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
13. Alert?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
14. Miserable?	Not at all	0	1	2	3	4	5	6	7	8	Extremely

<u>PLEASE WRITE DOWN THE CURRENT TIME</u>....................

SECTION 4: To be completed after your afternoon's work at the end of your working day

4.1 Below are listed a number of words that describe feelings and emotions. Please read each word and decide the extent to which each word applies to you **right now, at this present moment.**
(Please see 1.1 if you require an example)

Please remember to circle one number on each line.

1. Enthusiastic?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
2. Fatigued?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
3. Relaxed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
4. Lively?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
5. Tense?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
6. Irritated?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
7. Calm?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
8. Gloomy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
9. Tired?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
10. Uneasy?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
11. Annoyed?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
12. Cheerful?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
13. Alert?	Not at all	0	1	2	3	4	5	6	7	8	Extremely
14. Miserable?	Not at all	0	1	2	3	4	5	6	7	8	Extremely

PLEASE WRITE DOWN THE CURRENT TIME....................

4.2 Please think about the requirements and demands of your afternoons work, and then rate each of the following scales. Please remember to rate each scale for what **actually happened** during your work this afternoon.

Please remember to circle one number on each line.

1. How **difficult** did you find your work?	*Not difficult*	0	1	2	3	4	5	6	7	8	*Very difficult*
2. How **quickly** did you have to work?	*Not quickly*	0	1	2	3	4	5	6	7	8	*Very quickly*
3. How much **support** was available to you?	Not much	0	1	2	3	4	5	6	7	8	Very much
4. How much **spare time** did you have?	Not much	0	1	2	3	4	5	6	7	8	Very much
5. How much did you have to **do**?	Not much	0	1	2	3	4	5	6	7	8	Very much
6. How much **control** did you have over your work?	Not much	0	1	2	3	4	5	6	7	8	Very much
7. How much **mental effort** was needed?	Not much	0	1	2	3	4	5	6	7	8	Very much

4.3 Please write down the approximate number of minutes you spent on each of the following activities during your afternoons work. Please note that the total number of minutes should roughly equal the minutes in the afternoon work period.

1. How long did you spend working with a computer? ....Minutes
2. How long did you spend working with other people? (e.g. in meetings, talking to colleagues) ....Minutes
3. How long did you spend working on your own while not using a computer? ....Minutes

4.4 To what extent did you experience any of the following symptoms/problems this afternoon?

Please remember to circle one number on each line.

Headaches?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Eyestrain?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Backpain?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Difficulty concentrating?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Difficulty making decisions?	Not at all	0	1	2	3	4	5	6	7	8	Very much
Difficulty remembering things?	Not at all	0	1	2	3	4	5	6	7	8	Very much

4.5 Hassles are any events, thoughts or situations which make you aware that your goals and plans will be more difficult or impossible to achieve (either at all, or in the way you would like to achieve them). Such hassles are usually accompanied feelings such as annoyance, irritation, worry or frustration. Hassles occur very frequently and as such, are part of everyday working life. The feelings associated with them may last for quite a short time.

NOTE 1: The hassles (on the next page) are divided into non-computer work hassles and computer work hassles. Try as far as possible to separate out those which occured in connection with your work when you were not using a computer system and those that occured in connection with your work when you were using the computer system.
NOTE 2: Only circle N/A if it would have been impossible for the item to be a hassle for you this afternoon. For exmple if none of your work colleages was absent this afternoon (No. 1), or if you didn't use the E-Mail system (Nos. 15 & 17) these items should be circled N/A. Please remember to circle one number or N/A on each line.

4.5 (Continued). To what extent were the following items a hassle for you this afternoon?

Please remember to circle one number or N/A on each line.

NON-COMPUTER WORK HASSLES												
1. Absent work colleagues?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
2. Expected events not occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
3. Difficulty of tasks?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
4. Dull or monotonous tasks?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
5. Your own ability or knowledge?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
6. Interruptions from others?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
7. Tasks taking a long time?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
8. The type of demands placed on you?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
9. Being uncertain about how to proceed?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
10. Unexpected events occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
11. Realising you have a lot to do?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
12. Conflicts with other people?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
13. Letting other people down?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
14. Bureacracy or red tape?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
COMPUTER WORK HASSLES												
15. Accessing E-Mail?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
16. Exiting from programs/systems?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
17. Transmitting E-Mail?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
18. Bugs in software?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
19. Tasks taking a long time?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
20. Incompatability between systems?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
21. Failure/crash of program/system?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
22. Slow mainframe response time?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
23. Getting required printout?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
24. Your own ability or knowledge?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
25. Expected events not occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
26. Doing tasks the way you want to do them?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
27. Being precise in issuing commands?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
28. Making errors?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
29. System documentation?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
30. Slow printing?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A
31. Unexpected events occuring?	Not at all	0	1	2	3	4	5	6	7	8	Very much	N/A

THANK YOU VERY MUCH FOR COMPLETING THIS DAILY DIARY BOOKLET

PLEASE RETURN IT IN THE PRE-PAID ENVELOPE PROVIDED

APPENDIX A2.1

Covering Letter and Instructions sent with the first Weekly Diary Booklet

Medical Research Council

ECONOMIC AND SOCIAL RESEARCH COUNCIL

MRC/ESRC Social and Applied Psychology Unit
Department of Psychology
University of Sheffield
Sheffield S10 2TN

telephone 0742 756600

3 May 1989

Dear participant

SHEFFIELD WORK DEMANDS AND WELL-BEING STUDY

Please find enclosed the first of your Weekly Diary Booklets which you should fill in each day, starting from **Monday 8 May**. You will now receive one Booklet every week for eight weeks. Pre-paid envelopes are provided for their return.

Also enclosed are some brief instructions for completing the Weekly Diary Booklets. Please read these, and look at the Weekly Diary Booklet itself before you start to fill it in.

Many thanks to all of you who have returned the forms requesting your address. If you have not yet done so, we would very much appreciate it if you could return your form as soon as possible.

We hope that you find the Weekly Diary Booklet quick and easy to complete each day. A great deal of care has been taken in its design to ensure that it is clear and straightforward. However if you do have any queries, then please do not hesitate to contact us.

Thank you very much for your help and co-operation. We will be contacting you again in the next few weeks about completion of a special questionnaire, relating to long-term aspects of work and domestic experience.

Yours sincerely

pp Rob Briner

pp Dr G R J Hockey
Project Leader

pp Dr M Rahman

Enc

INSTRUCTIONS FOR COMPLETING THE WEEKLY DIARY BOOKLET

These instructions are set out in the form of questions and answers. Please read them carefully before you start to use the Weekly Diary Booklet.

There is also a brief guide to the contents of the Weekly Diary Booklet in the Booklet itself. Please also read these before you start to use it.

1. When do I fill in the Weekly Diary Booklet?

You should complete one page of the Weekly Diary Booklet **every day, including Saturday and Sunday.** Each Booklet runs from Monday to Sunday inclusive.

You should complete each day's entry late in the evening after you get home. **Just before you go to bed is an ideal time.** It is very important that you complete each page of the diary at the end of the relevant day. Please try to do this at all times. If you do forget, please complete it as soon as possible (in the morning, before you go to work).

2. How long will it take me each day?

It will take you **less then five minutes** each day to complete one day's entry for the Weekly Diary Booklet. For the first few days it may take you a little longer while you are getting used to the Weekly Diary Booklet.

3. When will I receive my Weekly Diary Booklets?

The Weekly Diary Booklets will be sent out to your home address (or in some cases your work address) a few days before you are due to start completing it.

You will receive one Booklet a week for eight weeks.

4. When should I return my completed Weekly Diary Booklet?

You should return your completed Weekly Diary Booklet **as soon as you have finished it.** Pre-paid business reply service envelopes will be provided for their return. You may use the normal postal service or if you prefer the internal mail service.

5. What do I do if I am on holiday?

If you are on holiday for a single period of **one or more weeks** then **do not** complete the Weekly Diary Booklet for that period. Please let us know as soon as you can if and when you will be on holiday for such a period. You may do this by sending us a note when you return your first Weekly Diary Booklet.

If you are on holiday for a single period of **less than one week** please complete the Booklet **as normal,** and indicate that you are on holiday.

THANK YOU

APPENDIX A2.2

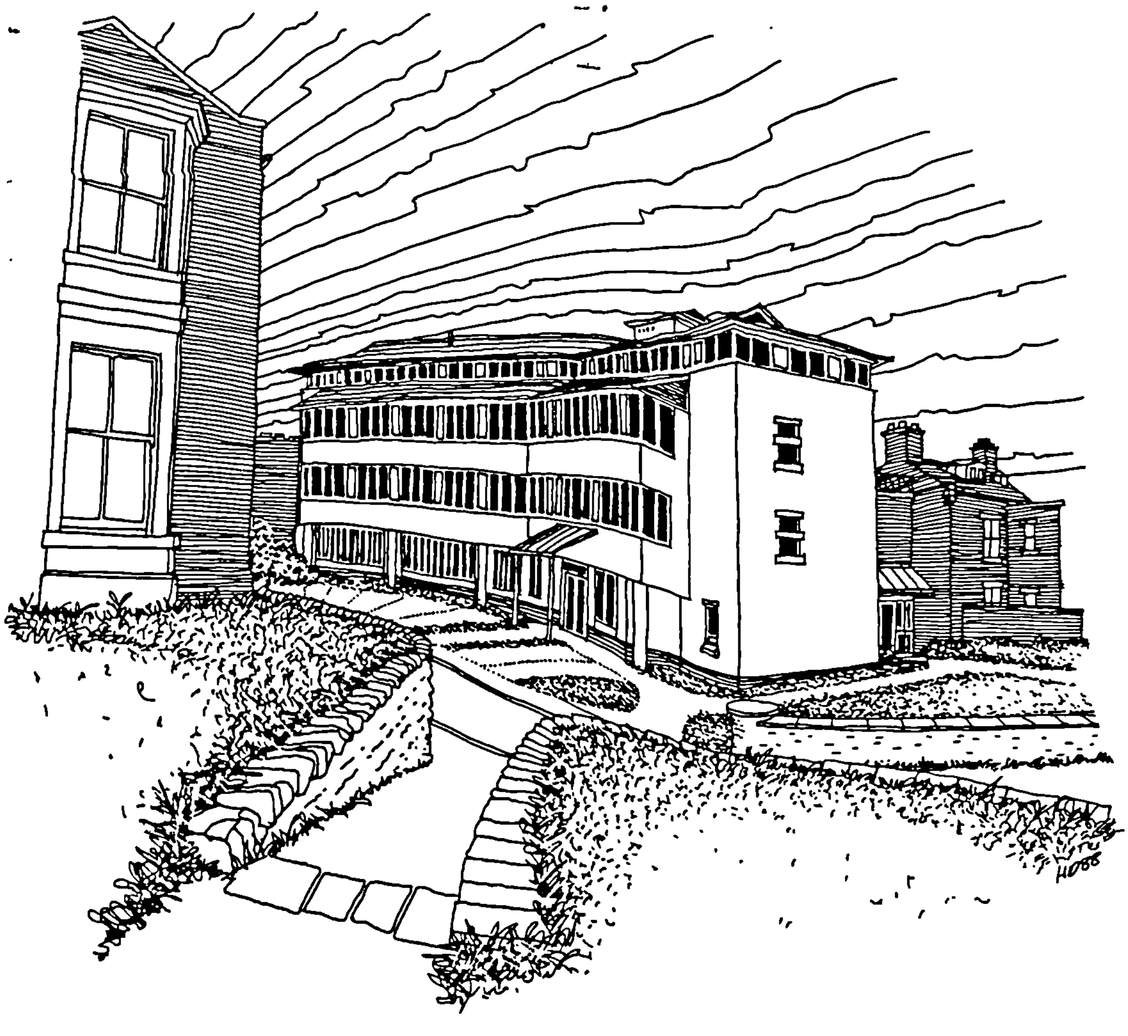
The Weekly Diary Booklet

SHEFFIELD WORK DEMANDS AND WELL-BEING STUDY

S174

WEEK 6
12 -18 JUNE

WEEKLY DIARY BOOKLET



MRC/ESRC SOCIAL AND APPLIED PSYCHOLOGY UNIT
UNIVERSITY OF SHEFFIELD
SHEFFIELD S10 2TN
TELEPHONE (0742) 756600

GUIDE TO THE WEEKLY DIARY BOOKLET

Please complete this daily diary booklet at the end of your evening. An ideal time would be just before you go to bed. It should only take a few minutes to complete.

How to indicate your responses in the Weekly Diary Booklet.

The places where you respond are enclosed by a box, as in the example below. Circle *one* number, or where appropriate a letter, on each line of numbers and/or letters, to express the *extent* of your response.

How much do you like watching television?

Not at all	0	1	2	3	4	5	6	7	8	9	Very much

In this example, *circling a number* towards the right *hand side* means that you like watching television very much. If you had circled a number towards the left it would mean that you tend not to like watching television. It is up to you which number you circle, but remember that you should circle the number (or where appropriate the letter) *which most accurately represents your answer to the question being asked.*

....

ON THE FOLLOWING FOLD-OUT PAGE ARE INSTRUCTIONS ABOUT EACH SECTION OF THE DAILY DIARY BOOKLET.

PLEASE OPEN OUT AND LEAVE OPEN WHEN YOU COMPLETE EACH DAY'S ENTRY AS A REMINDER TO YOU OF THE DEFINITIONS OF THE TERMS USED IN THE WEEKLY DIARY BOOKLET.

YOU MAY ALSO WISH TO USE THE FOLD OUT PAGE TO MARK YOUR PLACE IN THE WEEKLY DIARY BOOKLET.

....

Please remember that on every *other* week, the back of the Weekly Diary Booklet will contain some additional questions, printed on green pages, about the past two weeks. Before you return your Weekly Diary Booklet, please check that you have answered these.

THANK-YOU

PLEASE RETURN IN THE PRE-PAID ENVELOPE AS SOON AS YOU HAVE FINISHED

SECTION BY SECTION INSTRUCTIONS FOR THE WEEKLY DIARY BOOKLET

SECTION 1: WORKLOAD

1.1 **Please note** that you are only asked to give *approximation* of the time spent on these activities. Some of these catagories will overlap so do not worry if the hours add up to a little more than the hours you actually spent at work.

Definition of terms used in 1.1

COMPUTER-BASED WORK: Any work you do using a computer. This includes word processors, using a data base, *spread sheet etc.*

TYPEWRITING: Any work you do using a typewriter.

USING OTHER MACHINES: Any work you do using other machines. For example: photocopiers; switchboards; binding machines; calculators.

PAPER WORK: Any work you do with paper, but which *does not* involve using a computer or other machines. For example: filing; collating; using card indexes; processing forms; writing.

PHYSICAL WORK: Any work you do which involves a fair amount of physical activity. For example: walking some distance; carrying heavy objects such as books or boxes; moving machinery around.

WORKING WITH PEOPLE: Any work you do directly with other people. For example: meetings; dealing with clients, customers or visitors; working cooperatively with colleagues.

1.2 **Please note** that workload assessments should be *as objective as possible.* So when you are answering questions in this section report *what actually occured,* rather than what you would have liked, or what was supposed to happen.

Definition of terms used in 1.2

COGNITIVE DEMANDS: How much demand was there for cognitive activity? This means:
needing to think hard and make decisions
having to concentrate or making a lot of mental effort
feeling mentally rushed or busy.

EMOTIONAL DEMANDS: How much demand was there for emotional activity? This means:
finding things stressful or frustrating
having conflicts with other people
being upset or concerned about the welfare of others.

PHYSICAL DEMANDS: How much demand was there for physical activity? This means:
having to move about a lot
being on your feet for long periods
needing to do a lot of lifting or carrying of heavy things.

PERSONAL CONTROL: How much control was possible? This means:
opportunities to do things your own way
discretion or flexibility about the way in which jobs could be done
possibilities for using personal skills.

PERSONAL SUPPORT: How much support was available? This means:
being able to rely on other people when necessary
getting help when you needed it
feeling that others cared about your well-being.

1.3 **Please note** that personal effectiveness refers to your own perception of how effective you were at work today. This includes: feeling on top of the demands made on you; thinking and acting effectively; carrying out the things you have to do in a competent manner.

We are interested in your perceptions of your personal effectiveness in the use of two different kinds of skills at work, as defined below.

Definition of terms used in 1.3

SOCIAL AND INTERPERSONAL SKILLS: How effective were you in your personal dealings with people? This means:
handling difficulties and emotional problems with other people
communicating effectively with colleagues, clients and others.

JOB AND TASK SKILLS: *How effective were you in meeting work requirements? This means:*
making good use of your technical skills and knowledge
getting tasks and jobs done without difficulty.

SECTION 2: DAILY HASSLES

Please note that you should circle one number, or N/A (not applicable) for every item. There are two reasons why you might need to circle N/A:

Reason 1. If the items *does not apply to you today.* For example, if you didn't go into work, then *none* of the work hassle items (items 1-8) can apply, and should all be circled N/A.

Reason 2. If the item *could not apply to you at all.* For example, if you do not have any children, then item 13 ('My children') should be circled N/A *every time* you complete the diary.

Definition of terms used in Section 2

DAILY HASSLES: Daily hassles are problems and difficulties that are a part of everyday life. Hassles are any events, thoughts or situations which, when they occur:
A. Produce negative feelings such as annoyance, irritation, worry or frustration
and/or
B. make you aware that your goals and plans will be more difficult or impossible to achieve.
Hassles tend to occur very frequently and the negative feelings associated with them may last for quite a short time.

SECTION 3: HEALTH AND WELL-BEING

This section is on the whole self-explanatory. **Please note** that in 3.3 you may add any problems or complaints that you have experienced which are not included on the checklist.

SECTION 4: (OPTIONAL) ADDITIONAL COMMENTS

Please make use of this space to add anything further about your day, which is not covered by the rest of the diary. Do not feel obliged to write anything in this space. It is there only to provide an opportunity for you to make additional comments, if you so wish.

MONDAY

Today's Date: [/ /] Current time: [ ]

SECTION 1: WORKLOAD
Please note: **If you have not been at work today,** please go on to section 2.

1.1 Please indicate how many hours you spent at work today and then *approximately* how many hours you spent on each of the following activities during your day at work. (Circle one number on each line).

Computer-based work?	0Hrs	<1Hr	1-2Hrs	2-3Hrs	3-4Hrs	>4Hrs
Typewriting?	0Hrs	<1Hr	1-2Hrs	2-3Hrs	3-4Hrs	>4Hrs
Using other machines?	0Hrs	<1Hr	1-2Hrs	2-3Hrs	3-4Hrs	>4Hrs
Paper work?	0Hrs	<1Hr	1-2Hrs	2-3Hrs	3-4Hrs	>4Hrs
Physical work?	0Hrs	<1Hr	1-2Hrs	2-3Hrs	3-4Hrs	>4Hrs
Working with people (meetings etc)?	0Hrs	<1Hr	1-2Hrs	2-3Hrs	3-4Hrs	>4Hrs

Total time spent at work today? ....Hrs

1.2 Please indicate the workload for your day at work on the following dimensions. Please see definitions of dimensions at front of weekly diary booklet. (Circle one number on each line).

Cognitive Demands	Not at all	0	1	2	3	4	5	6	7	8	9	very much
Emotional Demands	Not at all	0	1	2	3	4	5	6	7	8	9	very much
Physical Demands	Not at all	0	1	2	3	4	5	6	7	8	9	very much
Personal Control	Not at all	0	1	2	3	4	5	6	7	8	9	very much
Personal Support	Not at all	0	1	2	3	4	5	6	7	8	9	very much

1.3 How personally effective were you in using these skills during work today?

Social and Interpersonal Skills	not at all effective	0	1	2	3	4	5	6	7	8	9	extremely effective
Job and task skills	not at all effective	0	1	2	3	4	5	6	7	8	9	extremely effective

SECTION 2: DAILY HASSLES
Please indicate the extent to which each of the following items was a hassle for you, that is caused you any concern, upset or difficulty. These may have occured at work or outside work. Please circle one number on each line or circle N/A either if the item *does not* apply to you today (eg. if you did not go into work today) or if the item *could not* apply to you (eg. you do not have any children).
How much of a hassle was each item for you over the day as a whole?

1. My work colleagues	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
2. My work supervisors or employers	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
3. The nature of my work	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
4. My workload	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
5. Meeting deadlines	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
6. Using computer/wp	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
7. Using other equipment	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
8. Clients or customers at work	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
9. My partner or spouse	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
10. Family or relatives	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
11. Friends and neighbours	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
12. Housework	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
13. My children	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
14. Financial circumstances	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
15. My health	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much
16. My physical appearance	N/A	Not at all	0	1	2	3	4	5	6	7	8	9	Very much

MONDAY

SECTION 3: HEALTH AND WELL-BEING

3.1 Please indicate your mood or general state over the *day as a whole.* Please circle any one of the numbers on each line which best describes your mood (where 0 = very much like the mood described on the left and 9 = very much like the mood described on the right).

Tired	0	1	2	3	4	5	6	7	8	9	Alert
Calm	0	1	2	3	4	5	6	7	8	9	Tense
Interested	0	1	2	3	4	5	6	7	8	9	Disinterested
Anxious	0	1	2	3	4	5	6	7	8	9	Relaxed
Enthusiastic	0	1	2	3	4	5	6	7	8	9	Depressed
Energetic	0	1	2	3	4	5	6	7	8	9	Fatigued
Miserable	0	1	2	3	4	5	6	7	8	9	Cheerful
Detached	0	1	2	3	4	5	6	7	8	9	Involved

3.2 Please indicate by circling one number on each line how you slept last night and how *refreshed* you felt this morning.

1. General sleep quality?	very poor	0	1	2	3	4	5	6	7	8	9	very good
2. Falling asleep?	very easy	0	1	2	3	4	5	6	7	8	9	very difficult
3. Night awakenings?	none	0	1	2	3	4	5	6	7	8	9	many
4. Feeling refreshed?	not refreshed	0	1	2	3	4	5	6	7	8	9	very refreshed

3.3 Have you experienced any of the following, however slight, today? Please circle yes (Y) or no (N) for each item.

Difficulties concentrating	Y	N	Difficulties with memory	Y	N	Difficulties with making decisions	Y	N
Muscular aches	Y	N	Upset stomach	Y	N	Feeling drowsy	Y	N
Feeling weak	Y	N	Lack of vitality	Y	N	Poor appetite	Y	N
Dizziness	Y	N	Eyestrain	Y	N	Menstrual pains	Y	N
Headache	Y	N	Back pain	Y	N	Chest pain	Y	N

Other? (Please write below)

_______________ _______________ _______________

SECTION 4: (OPTIONAL) ADDITIONAL COMMENTS