STRESS RESEARCH: ITS PRESENT STATUS AND ISSUES FOR FUTURE DEVELOPMENTS

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Abstract—In this article the contribution of nine approaches to stress research is discussed. These approaches are: (1) the biological approach; (2) the (classic) psychosomatic approach; (3) the life event approach; (4) interactionistic or transactional approaches; (5) life style and behavior; (6) group differences; (7) sociocultural (macro-)factors; (8) work and organizational psychology; and (9) intervention and prevention. It is concluded that, more and more, exchanges take place between different approaches and that the willingness to collaborate increases. Not only do we observe collaboration between different disciplines, there also are examples of an integration of laboratory research and field research. In addition, interest of animal workers for human research and vice versa seems to increase. Although it is realized that stress research has its own inherent characteristic problems (e.g. ethics), the authors feel that the future still can bring important progress.

INTRODUCTION

More or less traditionally review articles on 'stress' start with pointing to the lack of agreement on the terminology used in this field of research. One anonymous researcher pithily summarizes this disagreement by stating that stress "in addition to being itself, and the result of itself, is also the cause of itself" [1]. However, while there thus seems to be much controversy concerning the definition of concepts, we think there will be much more consensus on what kind of studies may be covered under the heading 'stress research'. Without having the intention of formulating a clear definition we want to present a rough description. The main core of stress research is formed by studies that focus on psychobiological (electro-physiological, endocrine or immunological), psychological (performance, cognitive functioning, emotional life), or social functioning as the function of experience with a stimulus or situation that generally is appraised as aversive or unpleasant. Special attention is devoted to the way people try to cope with such stressful experiences. In addition, attention is paid to interventions or preventive actions aimed at opposing or neutralizing the adverse (health) effects of such encounters.

In the past decades 'stress' has aroused the interest of scholars of many disciplines. But it is especially the behavioral sciences that show an enormous increase in the number of publications pertaining to the topic 'stress'. Figure 1 shows the increase in absolute numbers of publications under the heading 'psychological stress' during the period 1976–1985 for two (not mutually exclusive) databases: Psychological Abstracts and MEDLARS. Whereas the MEDLARS database shows a gradually nearly two-fold increase, the Psychological Abstracts database shows a sharp rising growth in the years 1981–1982, resulting in a three-fold increase. This finding suggests that the greatest research efforts have been invested especially in the behavioral sciences.

Given this dramatic rise in the number of articles on stress we feel that the time is ripe for reflection. What has stress research yielded? Can we discern between promising avenues and dead-end streets? We are convinced that much unnecessary research is done, while, on the other hand, important questions remain to be tackled. A similar conclusion can be read in the panel reports of the Institute of Medicine [2] and in the article by Payne et al. entitled: "Whither stress research? An agenda for the 1980s" [3].

Fig. 1. Absolute number of publications covered under the descriptor 'psychological stress' in two literature bases: MEDLARS and Psychological Abstracts. MEDLARS1 represents the number of articles for which 'stress' is a central issue. MEDLARS2 covers a broader range. The data for 1985 have to be considered as preliminary.
It must be recognized that a lot of research in the stress field is of doubtful quality. This may be due to methodological weakness or due to the practical constraints or ethical considerations which make themselves felt in stress research. It indeed must be acknowledged that stress researchers often have to satisfy themselves with next-to-best or even worse solutions. Inherent to stress research are the inevitable trade-offs between rigid experimentation, well-controlled studies of the short-term reactions to acute stressors, and naturalistic and/or quasi-experimental investigations mostly focussed on health-related variables [4].

Syme [5] discussed the characteristic difficulties in research on the role of socio-cultural factors in disease etiology. He concludes: “In this circumstance, where no one study can be regarded as definitive and free of flaws, it may be necessary to look instead for consistent patterns of findings among various studies. Instead of settling an issue with one conclusive research project, it may be that we have to ‘surround’ the issue with several different, imperfect projects. While each of these projects may be imperfect, the fact that so many different approaches yield the same pattern of findings should merit our attention” [5, p. 16]. We believe that this point of view also applies to other approaches in the stress research field.

The last point we want to make concerns the relationship between scientific, more academic questions and the practical relevance of particular findings. This can be illustrated with the following example: several investigators criticize the value of the life event approach because of the fact that the dependent variable is not adequate. It is argued that the dependent variable measured (e.g. hospitalization or doctor visits) is an indication for illness behavior rather than for disease. This may be fully correct, but that does not mean that the research is of limited value. Of course, such research is rather useless to answer the question whether there is a relation between stress and disease; however, policy makers and other people interested in the economical aspects of health care may consider such a finding very relevant. The same applies to the issue of social support. Although there is much debate on how to conceptualize social support and on the way it must be measured, the simple finding that a particular intervention positively influences the well-being and/or physically functioning in particular groups of people (e.g. the elderly or the bereaved) also is very important for the field. A field like this, where fundamental research and applied research come to meet each other for outsiders easily may evoke the impression of controversy and discord. Therefore, it is important that the workers in the different disciplines know something about the background and objectives of the people with whom they perhaps will collaborate in future.

In the present article, we do not have the intention to judge the quality of work within each approach, rather we want (1) to disentangle the stress field into its different elements; (2) shortly review what their contributions to stress research implied; and (3) discuss the future possibilities and constraints (without having the pretention of being exhaustive).

Concerning the last point, the following possibilities can be distinguished: (1) developments within each of the below mentioned approaches; (2) integration of different approaches; (3) new approaches or stimulation of rather undeveloped lines of research.

Analyzing the studies relevant for stress research, the following roots can be traced:

1. the biological tradition;
2. the (classic) psychosomatic approach;
3. life event research;
4. interactionistic or transactional approaches;
5. life style and behavior;
6. group differences (social class, sex, race) in vulnerability;
7. sociocultural (macro) factors and vulnerability;
8. work and organizational stress research;
9. intervention and prevention.

1. THE BIOLOGICAL TRADITION

Walter Cannon and Hans Selye both are well known names with respect to biological oriented approaches in stress research. As most of the readers will know, Walter Cannon showed that (in addition to stimuli of a physical nature) psychological stimuli also could activate the physiological system of an organism, in particular the sympathetic division of the autonomic nervous system and the release of adrenaline and noradrenaline by the adrenal medulla. Hans Selye, in his theory, especially emphasized the role of the adrenal cortex, secreting corticosteroids, and explicitly formulated hypotheses concerning the relationship between short-term stress reactions and their endpoints (i.e. the so-called diseases of adaptation).

Far less known is the work of the French scientist Reilly who, nearly at the same time as Selye published his theory, described the so-called “Irritation Syndrome” or “Phenomena of Reilly” [6, 7]. These observations revealed the important role of the autonomic nervous system, when the organism is exposed to noxious stimuli. The advancement of this structure seemed to precede the arousal of the neuroendocrine system, on which Cannon and Selye focused their attention. Considering Selye’s General Adaptation Syndrome and the Phenomena of Reilly, Smelik [6] therefore concluded that both concepts started from different random observations on either endocrine (Selye) or autonomic nervous phenomena (Reilly) and consequently have developed to generalized theories which were limited by their own starting point. Modern stress research shows that both fundamentally different lines came to meet each other at the level of the central nervous system.

In summary, the biological approach traditionally directed their attention to the (mainly short term) somatic reactions of organisms to aversive stimulation.

The theory of Selye, although popular in the medical and physiological sciences, was strongly attacked by several investigators [7]. Important consequences of this criticism were, in the first place, that investigators were stimulated to direct their attention to hormonal variables other than the adrenocortical substances and, second, that students in animal experimentation became interested in the possibilities of ‘psychosocial’ animal research [8-10].
The model proposed by Henry and Stephens [11] can be seen as a major example of this development. This model is an integration of the major concepts of Walter Cannon and of Hans Selye. It hypothesizes that, dependent on the outcome of the 'appraisal' processes, two possible responses may ensue. In the case of loss of control, when the organism has no adequate coping response available, the hippocampal-pituitary-adrenal cortex is triggered. This response, at the behavioral level is accompanied by restricted mobility, subordination, and low sex and maternal drives ("conservation-withdrawal"). However, when behavioral efforts may be useful, either to remove the source of the threat or to escape, then the amygdala and the sympathetic adrenal-medullary system is activated. The behavioral features of this 'fight-flight' reaction are territorial control with mobility, display, and aggression. In short, this model thus links the respective physiological patterns of Selye and Cannon to specific coping patterns.

Vingerhoets [7] elaborated on this approach and tried to integrate this model with the coping theory by Lazarus and Folkman [12]. It is very intriguing to see the remarkable correspondence between the human data of Vingerhoets [7] and the animal (rat) data of Bohus and associates [9, 10]. Vingerhoets found that men who prefer a problem focused coping style to an emotion focused coping style have higher plasma catecholamine levels and testosterone levels. Bohus found the same variables differentiating between active and passive rats. A second parallel between animal and human data reported by these investigators concerns the importance of the parasympathetic nervous system in situations characterized by loss of control.

The present authors consider it to be one of the greatest omissions that, even now, many physiologically oriented investigators do not take into account the psychological aspects of a specific stimulation procedure. The mere observation that a particular situation results in the release of catecholamines or other hormones does not add much to our understanding of stress phenomena. What we rather need is a careful evaluation of the stimulus or situation to find out what it is that makes the stimulus a stressor. Alternatively, it would be worthwhile to study the reactions to a certain situation as a function of specific genetic features or previous experiences. It is rather remarkable and disappointing that, since the classic work of Weiss and collaborators in the late sixties [13] who showed the importance of the psychological dimension when applying aversive stimulation, virtually no new work has been done on this topic. Moreover, interesting hypotheses can be formulated concerning the relationship of the catecholamines and corticosteroids and psychological concepts such as active and passive coping, but until now these substances have hardly ever been investigated together. Therefore, it is important that psychologists and physiologists be encouraged to work together. In this regard, we fully agree with Baum and coworkers who also may be considered as proponents of such an integrative approach [14].

Their studies of stress among people living near the Three Mile Island Nuclear Power Station [15] provide a good example how appraisals determine the biological reactions. The same holds for their interesting studies with unemployed subjects [16].

Another issue that deserves the attention of biological investigators is the study of mechanisms through which (short-term) physiological stress reactions can result in (long-term) adverse health effects. What is the relationship between short-term biological (e.g. endocrine) reactions and immunological parameters? And, to what extent are the decreases in immunological functioning often found in experimental research relevant for clinical practice? Whereas there is a host of psychological variables that are studied as possible predictors in prospective research concerning all kinds of physical and mental disturbances, the use of biological parameters as such, until now, is very limited. Nonetheless, some interesting hypotheses can be raised, e.g. concerning the value of recovery time of biological variables after the confrontation with a stressor, as a predictor for health risks.

Of course there are several practical limitations to human biological stress research. Economical aspects (such as the costs of assaying blood samples) but especially ethical considerations lay heavy restrictions on the possibilities. Both laboratory experimentation and natural setting research have their pros and cons. Therefore a careful consideration is required before deciding how a specific research question may be attacked. Dimsdale [17] elaborates on the generalizability of laboratory findings to field settings and observed that there was no response consistency for any of their subjective or hormonal measures from the laboratory to the field task. He therefore concluded that both controlled laboratory observations and naturalistic field observations are needed to understand the psychophysiological responses evoked by psychological stimuli.

The observation that there are a number of research questions left unanswered, however, may not obscure the fact that there also are areas in which important progress has been made.

In the biological tradition technologies have become available to assay not only catecholamines and corticosteroids, but also other pituitary hormones like β-endorphin, MSH, and substances that may play a role in the interaction of the brain and the immune system. Probably the progress in psychobiology at the moment is especially due to the rapidly increasing knowledge in the field of psychoneuroimmunology.

Other developments have to do with technical equipment such as withdrawal pumps that allow for continuous blood sampling and telemetric recording equipment for the recording of psychophysiological variables in more natural settings. Advances also have been made in the area of data analysis of psychophysiological variables. This especially holds for the analysis of cardiovascular and encephalographic data. The introduction of techniques such as power spectral analysis can lead to new insights into the reactions of the cardiovascular system to qualitatively different stressors and can perhaps add to our understanding of the relation between short-term reactions and baseline values.

Furthermore, considerable research efforts have been invested in the study of techniques that claim to
be useful to counteract the adverse health effects of stress. For example, Benson and associates [18, 19] did a good deal of work on the physiological aspects of the relaxation response. The same applies for outcome studies of biofeedback, autogenic training, hypnosis, meditation, etc.

In addition, there are some good examples of how psychophysiologicalists made use of concepts of other approaches and, vice versa, how psychobiological measures more and more are applied in field research to serve as a more objective marker of stress. This holds equally well for the life event approach as for ergonomics and organizational psychology and for the evaluation of prevention and, especially, intervention programs.

The early work by Lazarus and associates already showed how the physiological reactions to stressful films differed as a function of appraisal and/or coping style [20]. A recent illustration is the interesting work of Bandura and collaborators [21]. These investigators studied catecholamine secretion as a function of perceived self-efficacy of phobics to deal with their phobic stimulus. Thus, instead of taking objective measures (e.g. distance between subject and phobic stimulus) as an independent variable, emphasis was on the subjective reports of whether they could endure the confrontation. Their results showed a most interesting pattern. As long as the subjects reported that they could cope with the situation, the catecholamines were elevated. However, when they stated that they were completely inept at handling the catecholamine levels show a sharp drop. We think that it is unfortunate that the activity of the pituitary-adrenocortical-axis was not measured simultaneously. Provocative also is the already mentioned work by Baum and associates, especially where they studied people who had lost their job, in different phases of unemployment [16]. Their results indicate that the most stressed subjects show a rather clear pattern of altered psychological and biological functioning. The next necessary step is to use such data as predictors in a prospective design. The same applies to data of an immunological nature. Until now, one does not know whether the changes in immune function which often are found to occur after a stressful encounter, have predictive validity with respect to contracting disease. This problem also holds for dependent variables in stress research that are known as risk factors for certain disease (e.g. blood pressure or cholesterol).

2. THE (CLASSIC) PSYCHOSOMATIC APPROACH

It is generally agreed upon that the classic 'strong' psychosomatic model is no longer tenable as a valid explanation for the onset of somatic disease such as asthma, hypertension, hives, colitis ulcerosa and acne [21]. With 'strong' psychosomatic model we refer to the formulation that a disease can be caused by a specific intrapsychic conflict, perhaps even in the absence of predisposing physical pathology. In addition, there is the specificity of attitude hypothesis put forward by Graham and associates [22]. This hypothesis states that specific attitudes are associated, not only with etiology, but also with the clinical course of disease. Characteristic for both approaches is the specific relation between psychologic states and disease entities. This means that one particular conflict (emotion) or attitude predisposes a person to asthma, while another conflict is associated with, for example, lip, migraine or low back pain. Several recent investigations clearly discredit theories of etiology based on intrapsychic conflict. This is not to say that psychosomatic theory did not have its merits. The attraction of the attention away from pure biomedical factors may be considered as a break-through in the way of thinking about the different etiological aspects of physical disease. Such a development can be clearly illustrated by tracing the career of a man as the great George Libman Engel. His early work on colitis ulcerosa and fainting, larded with classical psychosomatic thoughts, eventually resulted in his formulation of the biopsychosocial model as the counterpart of the biomedical model. In addition, modern thinking concerning the role of anger in the onset of hypertension and/or myocardial infarction probably has its roots in the work of the classic psychosomatic school. Without doubt the concepts of this approach may form a rich source of inspiration for modern investigators. As such the importance of this approach may not be overlooked.

More or less directly originating from this approach are two lines of research which will be discussed below: (1) personality as an etiologic factor, and (2) specific psychological states predisposing to disease.

**Personality and vulnerability**

The question whether particular personality profiles are of relevance for the etiology of specific diseases go all the way back to more than 2000 years ago. For example, Galen stated that melancholic women developed breast cancer more often than did sanguine women. Ever since that time, the literature has been full of contradicting findings and conflicting theoretical positions. On the one hand, there is the estimate that it is more likely that there exists a specific chronic disease personality rather than that each specific disorder has its own characteristic personality pattern [23]. On the other hand, there is evidence that type A behavior may be specifically associated with cardiac disease, but not with other diseases like cancer [24]. Empirical findings even suggest that cancer patients and myocard infarction patients often score on opposite ends of scales measuring psychosocial variables [25].

Very interesting results yielded the investigations by Grossarth-Maticzek and associates [26]. In their prospective studies they succeeded in predicting rather accurately the mortality of cancer, cardiovascular disease and stroke. Although many investigators have expressed their feelings of doubt concerning the findings of Grossarth-Maticzek, their results, nevertheless, deserve consideration, and it would be of utmost importance if a replication study were carried out.

Another approach within this context does not focus on specific groups of disease, but rather tries to determine the relevance of personality as a co-determinant of general susceptibility or vulnerability. For example, personality characteristics can be conceived of as moderator variables; that means that
an association between stressful life events and decreased mental and/or somatic functioning only holds for people with a specific personality pattern. Among them the personality variables mostly studied are sensation seeking, hardness and neuroticism. Several studies indeed showed that the stress–illness relationship exclusively holds for individuals with a specific personality profile. In short, it is hypothesized that certain personality features render a person more or less resistant to stress; in other words, personality characteristics determine the outcome of a stressful interaction.

But there is also a second theoretical link between personality and stress. That alternative hypothesis states that some personality types are more ‘stress-seeking’ than others. Kasi [27] is a proponent of this view. He wonders whether life events can be seen as independent of person characteristics. He mentions, for example, heroin addicts and alcoholics as groups with very high annual frequencies of life experiences. In addition, Byrne [28] reported similar findings for type A persons. Therefore, it is important that empirical data are collected concerning this issue to establish the relation between these concepts.

**Psychological states predisposing to disease**

Not only personality has been the object of study as a predisposing factor of disease, interest also has been directed to specific psychological states. It was especially the Rochester group of investigators (Engel, Greene, and Schmale) who stressed the importance of the so-called “giving-up, given-up” complex as a prodrome of physical disease [29]. A key factor triggering this complex is the actual or threatening loss/separation from highly valued persons, life goals or places. The most characterizing features are a loss of motivation; feelings of helplessness or of hopelessness, i.e. the feeling of being unable to cope; a depreciated image of the self; a feeling of disruption of the senses of continuity between past, present, and future; and a reactivation of memories of earlier periods of giving-up. It is assumed that this psychological state is accompanied by specific biological changes, such as a predominance of parasympathetic activity and a relative sympathetic inactivity plus a dominance of hormonal anabolic activity over catabolic activity. Through these changes, the body ‘economy’ is hypothesized to be altered in such a way that the capability of the organism to deal with pathogenic processes is strongly affected, permitting disease to develop. Genetic and constitutional factors as well as early experiences are assumed to ultimately determine the character of the disease.

Schmale and Iker [30] designed a limited prospective study with women undergoing biopsy for cervical cancer. Based on the results of interviews given before the results of the biopsy were known, patients were classified as high or low in hopelessness. It appeared that women with diagnosed cervical cancer were significantly higher classified on this dimension. About three-quarters of the women could be correctly classified as having or not having a cancer, based on the interview data. It has been pointed out by Cohen [31], however, that pathological processes in cancer may cause psychological changes before the disease has become clinically manifest. In addition, Scherg [25] points to the results of other prospective studies yielding conflicting results.

Recently, Appels and coworkers [32] directed their attention to the prodromal phase of myocardial infarction and initially developed the concept of “vital exhaustion and depression”. In a later large prospective study it appeared to be especially the vital exhaustion component which was predictive (especially at the short-term level, i.e. within one year) for myocardial infarction and not for cancer. This result seems to challenge the view that psychological states predisposing to disease are nonspecific with respect to outcome. Therefore, further research is needed to clarify this issue.

Such conflicting findings, however, bring up another important topic. Unfortunately, at the moment, there is an explosive growth in the development of measuring tools used to operationalize more global concepts as coping, social support, depression, physical and mental health, etc. This development seriously hinders the mutual comparability of findings. Are conflicting findings really conflicting, or can they be attributed to the different measuring devices? A second related and regrettable fact is that there is not always an optimal fit between retrospective investigations and prospective studies. For example, in psychosocial cancer research, instruments that yielded promising findings in retrospective studies, until now, not yet have been applied in prospective research.

**3. THE LIFE EVENT APPROACH**

Ever since the seminal work of Holmes and Rahe much research effort has been spent to develop this approach to a more valid and methodologically more sound one. Nevertheless, even now, opponents and proponents strongly disagree on the value of this line of research. Critics not only disapprove its theoretical foundations, they also condemn the way in which both relevant variables (on the one hand, the life events, and on the other hand, the different indices of mental and/or physical health) are operationalized. It is beyond the scope of the present article to give an exhaustive enumeration of all problems that are identified in this research area. Besides, there are a number of recent reviews relating to this topic [33-37]. Alternatively, we would like to discuss some of these problems and their implications. Additionally, we want to point to some promising developments that could be helpful for a further maturization of this line of research. In the first place, as already stated elsewhere [37], we think that it is not correct to conclude, on the basis of life event research alone, that there is no relationship between ‘stress’ and disease. Vingerhoets [37] distinguishes at least seven other classes of stressors that are not accounted for in life event research. Therefore, it would be interesting and would give insight to obtain information about the proportion of ‘cases’ in the control group that is exposed to one or more of the other sources of stress. The seven categories are: (1) traumatic youth experiences; (2) chronic stressors; (3) daily hassles; (4) traumatic experiences; (5) ‘non-events’; (6) disasters and (7) stressors associated with the living and work situation. It, therefore, must be
realized that the concepts stress and life events are not synonymous.

A second important point is, that by far most of the criticism (e.g. unreliable measurement devices, incompleteness of the item pool, and dependency of events) directed at life change research would imply that the correlations found thus far underestimate the real relationship. Another point is how great a relationship one theoretically would expect to find [38]. Everybody knows that, fortunately, most people will not seriously be inflicted with stressful life changes. However, the same holds for medical risk factors; only a minority of those who smoke, who have high cholesterol levels and who do not exercise will develop health problems. Moreover, Cooke and Hole [39] criticize the use of the ‘explained variance’ index. They favor the use of an epidemiological measure of population attributable risk percent, which provides an accessible measure of causal impact since it measures the maximum percentage of cases that can be directly attributed to life changes.

As already mentioned, an increasing number of life change studies focus on the effects of potential moderator variables. In addition to the above mentioned personality variables, the interest of the investigators especially has been aroused by the factor social support.* Although it has to be noted that at present there is much debate on the dimensionality of the construct and how to measure it, it cannot be denied that in some studies impressive results have been reported.

Many theorists criticize the study of life events in the tradition of Holmes and Rahe, because it does not take into account the subjective evaluation of the event by the subject. To a large degree this subjective evaluation comprises what several investigators have pointed to as important features, such as negative or positive, unexpected or anticipated, and controllability [36].

Measuring health status also brings up many (conceptual) problems [40]. Illness behavior, to mention one of the more important, and other factors can invalidate the conclusion that there is an association between life stress and illness. Therefore, it is remarkable that, until now, only a few attempts to measure physiological activity as a function of experience with life events have been reported. To mention a few of them: Pardine and Napoli [41] compared heart rate and blood pressure reactivity to a laboratory stressor of subjects with high levels of life stress to the reactions of a low stress group. They found no differences in the reactivity (amplitude) between the two groups; however, it took significantly longer for the high stress group to return to pre-stressor baseline levels.

Their interpretation of these findings is based on the hypothesis put forward by Frankenhaeuser [42] stating that stress creates wear and tear in the organism and affects fast and adequate bodily reactions. Other interesting studies integrating the life change approach and psychobiology are published by Locke et al. [43].

*Much the same as for the relationship between personality and stressful life events, one may wonder whether social support also must be conceived of as a personality measure or as an independent environmental factor.

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Richard Lazarus may be considered the most important advocate of this approach. His 1966 book "Psychological stress and the coping process" [48] may be regarded as a break-through in theorizing on stress. There are two processes which take a central position in his theory: (1) appraisal and (2) coping. The concept of appraisal refers to the evaluation of the situation, in which two things are taken into account: (1) What is at stake? and (2) What can I do about it? If the subject feels a discrepancy between the demands of the situation and his/her capabilities, then a state of 'stress' develops. Because, in addition to the situational features, also the capabilities of the subject are important determinants whether a state of stress will develop, this theory may explain why "one man's poison may be another's food and drink".

The second important concept is 'coping'. This concept refers to "the process of managing external and/or internal demands that tax or exceed the resources of the person". Lazarus and coworkers repeatedly emphasized that, in their view, coping is a process that can be described in terms of a relationship between the person and the specific environment [49, 50]. As a consequence, they reject the trait approach of coping, which dominates coping research. The problem, however, is that it often yields serious problems in several research designs to take into account the dynamic nature of the coping process.

The Lazarus group distinguishes two types of coping: (1) coping behavior directed at the situation (overt reactions designed to modify the stressful situation = problem focused coping) and (2) managing emotional response (reducing feelings of distress = emotional focused coping). Until now, research completely grafted upon this theory is very limited. It is far more easy to refer to this theory to explain disappointing results, rather than to design studies which fulfill the requirements made by the theory to test a specific hypothesis. The dynamic nature of coping and appraisal requires a continuous monitoring of these processes; a requirement that, by definition, cannot be met. However, useful information can be gathered which enhances our understanding of the complex interplay between stimulus and person.

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4. THE INTERACTIONAL OR TRANSACTIONAL APPROACH

Richard Lazarus may be considered the most important advocate of this approach. His 1966 book "Psychological stress and the coping process" [48] may be regarded as a break-through in theorizing on stress. There are two processes which take a central position in his theory: (1) appraisal and (2) coping. The concept of appraisal refers to the evaluation of the situation, in which two things are taken into account: (1) What is at stake? and (2) What can I do about it? If the subject feels a discrepancy between the demands of the situation and his/her capabilities, then a state of 'stress' develops. Because, in addition to the situational features, also the capabilities of the subject are important determinants whether a state of stress will develop, this theory may explain why "one man's poison may be another's food and drink'.

The second important concept is 'coping'. This concept refers to "the process of managing external and/or internal demands that tax or exceed the resources of the person". Lazarus and coworkers repeatedly emphasized that, in their view, coping is a process that can be described in terms of a relationship between the person and the specific environment [49, 50]. As a consequence, they reject the trait approach of coping, which dominates coping research. The problem, however, is that it often yields serious problems in several research designs to take into account the dynamic nature of the coping process.

The Lazarus group distinguishes two types of coping: (1) coping behavior directed at the situation (overt reactions designed to modify the stressful situation = problem focused coping) and (2) managing emotional response (reducing feelings of distress = emotional focused coping). Until now, research completely grafted upon this theory is very limited. It is far more easy to refer to this theory to explain disappointing results, rather than to design studies which fulfill the requirements made by the theory to test a specific hypothesis. The dynamic nature of coping and appraisal requires a continuous monitoring of these processes; a requirement that, by definition, cannot be met. However, useful information can be gathered which enhances our understanding of the complex interplay between stimulus and person.

On the other hand, the notion that it is the subjective evaluation of the stressor, rather than its objective characteristics that determine the outcome of a
specific interaction greatly has influenced stress research. This holds for animal experimentation, human psychophysiology and life event research. However, as far as is known, until now data focussing on health related outcomes are very limited.

Coping is conceived in many ways by different investigators [7]. In experimental psychophysiology, animal experimentation, clinical psychology, and the life event approach the term 'coping' frequently is used. It now seems as if the interest of researchers is shifting away from the stimulus/situation towards coping. Coping is used as a dependent, independent, mediating, and moderating variable. Several operationalizations and measuring devices are used. Therefore, also in the present context it can be noted that it is very regrettable that there is little use of standardized measuring devices.

5. LIFE STYLE AND BEHAVIOR

Behavioral reactions to stress include both actions to remove the source of the threat or to escape from the situation, and reactions aimed at palliating the negative emotional consequences. To this last category ("emotion focused coping") belong several behaviors that are damaging to health. In addition to more or less involuntary reactions (e.g. disturbed sleeping patterns, loss of appetite) one can think of more voluntary behaviors such as drinking alcohol and cigarette smoking. When these coping mechanisms evolve into habits they can become risk factors for several kinds of diseases. The same holds for other health related behaviors such as sensitivity to physical symptoms or minimizing their significance. As a consequence, seeking medical care may be delayed or compliance with medical regimes may be decreased. In this way stress may affect vulnerability on an indirect level, in addition to the more direct biological effects of stress which may disrupt homeostasis resulting in aggravation or initiation disease. Matarazzo [51] introduced the term "behavioral pathogen" to denote the personal habits and life style behaviors of the individual which are important etiologic factors for many of the most important causes of mortality. This author quotes Califano [52] who stated that of the ten leading causes of death in the United States "at least seven could be substantially reduced if persons at risk improved just five habits: diet, smoking, lack of exercise, alcohol abuse and use of hypertension medication". Bellac and Breslow [53] presented the results of a survey of a representative sample of 6928 American adults. It was found that seven habits were highly correlated with the physical health of these people: (1) sleeping seven to eight hours daily; (2) eating breakfast almost every day; (3) never or rarely eating between meals; (4) currently smoking; (5) never smoking cigarettes; (6) moderate or no use of alcohol and (7) regular physical activity. In their initial survey, they showed that those adults who followed all or most of these seven 'good' practices were in better general health than those who followed none or few. In addition, a follow-up study had been carried out over a period of 5.5 years. It was shown that summing up the practices for each individual resulted in a clear relationship to mortality at follow-up. For both men and women in each age group mortality was lower for those individuals who followed most of these seven health practices. These results were the more impressive because of the finding that this relationship was independent of the individual's 1965 level of income and, more important (except for a very small subsample), independent of the 1965 health status. A second—9.5 year—follow-up revealed that men who followed all seven health practices had a mortality rate only 28% of that of men who followed zero to three practices. These findings thus seem to suggest that one's health status is not independent of one's life style. Therefore, stress may have important indirect consequences if it influences behaviors that are relevant for maintaining one's health. The implications for prevention will be discussed in the specific section on that topic.

6. GROUP DIFFERENCES IN VULNERABILITY

The most important and most frequently studied group differences concern: (1) gender differences; (2) social class differences; (3) differences in marital status; and (4) race differences. Here we will restrict ourselves to the first three differences.

Gender differences

With respect to gender differences in vulnerability, there appear to be some paradoxes. On the one hand it has been established that women have lower death rates for nearly all kinds of diseases, but, on the other hand, women have higher morbidity rates. This holds both for physical disease and mental disease. For example, community surveys show that adult women are twice as likely as men to report extreme levels of psychiatric distress. In an excellent review article, Verbrugge [54] presents the state of the art with respect to gender differences and discusses the current hypotheses. She adheres to the viewpoint that sex differences in health are principally caused by differential risks acquired from roles, stress, life styles and preventive health practices. Less important are the ways men and women deal with symptoms and their readiness to make use of medical resources. Last and least, in her view, are other factors such as biological risks, health reporting and caretaker effects. With respect to stress, Verbrugge [54] points to the differences in coping between men and women. According to her, women maintain stronger emotional ties with other people. When being distressed, they "buffer the route from stress to disease by reacting in more benign ways", e.g. turning to the people who are close to them and using medical drugs. In contrast, men choose more often for quiet brooding, using alcohol or illicit drugs or smoking. This partly may explain the fact that, whereas women suffer from more frequent, but typically not serious disease, men have more life threatening diseases, which cause more permanent disability and earlier death.

Froberg et al. [55], in their discussion on women's multiple roles and their health status, arrive at similar conclusions. The studies they describe especially focused on two hypotheses: (1) the scarcity hypothesis
which emphasizes energy limitations and role strain, and (2) the expansion hypothesis focusing on gratification derived from accumulating diverse roles. The results of empirical research indicated that, in general, those who have several roles are healthier than those with few, although it may not be excluded that such a finding (partly) reflects the so-called 'healthy worker effect', i.e. the selection of healthy women into the labor force, rather than the effects of employment on health. Froberg et al. [55] therefore caution against generalizing because that may obscure health differentials associated with specific types of roles and attributes of these roles. Nowadays, emphasis is laid more on the analysis of the effects of specific role combinations, patterns and characteristics. Finally, these authors point to the need to identify ways in which rewards and stresses within each role interact to produce a particular (either negative or positive) health outcome.

Social class differences

Kessler et al. [56] state that one of the oldest and most firmly established associations in psychiatric epidemiology is the one between social class and mental illness. People in socially disadvantaged positions have been shown to have higher rates of psychiatric disorder than their more advantaged counterparts. Research showed that this class difference was not caused by the fact that lower class people were exposed to more stressful life experiences. Rather, it appeared that stressful life experiences have a greater capacity to provoke mental health problems in the lower class than in the middle class. In other words, their coping efforts are assumed to be less adequate. However, not only mental health problems are more prevalent in the lower socio-economic classes, the same holds for infections and parasitic diseases, infant mortality rates and actually nearly all causes of death. Research showed that stressful life experiences have a greater capacity to provoke mental health problems in the lower class than in the middle class. In other words, their coping efforts are assumed to be less adequate. However, not only mental health problems are more prevalent in the lower socio-economic classes, the same holds for infections and parasitic diseases, infant mortality rates and actually nearly all causes of death. Kessler et al. [56] summarize evidence suggesting that lower class people are disadvantaged in their access to supportive social relationships. In addition, these authors point to evidence that personality factors associated with vulnerability to stress such as low self-esteem, fatalism, and intellectual inflexibility are more common among lower class people. It has not yet been definitely settled which explanation of this class-linked vulnerability fits best with empirical findings. One hypothesis states that some type of selection or 'drift' of incompetent copers to the lower classes might lead to this association. Another explanation is just opposite: being a member of a disadvantaged group leads to the development of individual differences in access to sources of social support. These hypotheses are worth being considered because the more obvious explanations such as poor housing, increased exposure to noxious agents and poor medical care have been found to be inadequate to explain the large number of diseases associated with socio-economic status. Finally, it must not be overlooked that health related patterns of behavior may be valued or disparaged in a given social environment. Attitudes towards eating, smoking and actively participating in sports and drugs abuse are affected by the general value system of the direct social environment.

Marital status and vulnerability

It has been firmly established that disruptions to intimate social relationships are associated with elevation of morbidity and mortality. Sterling and Eyer [57] summarize some of the most important findings. The data show that the death rates for widowed and divorced are higher at all ages than for married people. Although a number of alternative hypotheses may be put forth (e.g. marital partners often share a number of behaviors, live in the same housing conditions, in the process of choosing a partner health variables may play a role, etc), there is a host of evidence that the loss of a beloved person negatively can influence one's health status. Bereaved people have been studied many times and by investigators of different disciplines. The picture that emerges seems rather consistent. It has been found that bereaved people have elevated risk to die from several causes in the first period after the loss [47,58,59]. In addition, it has been shown that the activity of the adrenal cortex is influenced, and that the immunological functioning is affected [59].

It seems attractive to make a link with the literature on social support. The role of this factor may be seen on two different levels: (1) the perception level on which the definition of the situation occurs, and (2) on the level of coping. People with strong social support are likely to perceive unemployment, divorce or bereavement as less serious problems than people low in support. On the other hand, the possibility to receive social support may act as an efficient buffer against maladaptive effects of stressful situations. As such it seems a rather effective coping mechanism. Shuval [60] points to still another aspect. Informal social networks may exert pressure on their members to conform norms of preventive health care. In addition, other people may call attention to early signs of illness ("you look pale today") or to behavior that could be conducive to illness (failure to prepare regular meals, stopping exercising, etc).

7. SOCIOCULTURAL MACROFACTORS ON VULNERABILITY

Differences between cultures in a sense are closely related to the just discussed social class differences in vulnerability. Very impressive are the findings by Syme and associates [61] who showed that the differences in cardiovascular mortality rates between Japanese immigrants to different parts of the United States could not be accounted for by nutritional factors or other biomedical risk factors. Rather, it appeared that the Japanese culture provided them a very efficient protection against myocardial infarction. Studies with Japanese immigrants in the United States further showed that when those people assumed the American way of life, their morbidity and mortality rates for cardiovascular disease more and more resembled those of the Americans [62]. A corresponding finding was reported by Wolf and coworkers [63] who studied the population of Roseto, a traditional Italian-American village in eastern Pennsylvania. Their results suggested that the unusually low incidence of death from myocardial infarction in this village could be contributed to
social factors, rather than to dietary habits or cholesterol levels.

Henry and Cassel [64] reviewed the evidence that there are cultural groups all over the world whose blood pressures are low and do not change with age; moreover, coronary and hypertensive heart diseases and strokes are rare in such cultures. Based on such findings it was concluded that people living in a stable society and well-equipped by their cultural background to cope with the demands of their direct environment will not show a rise in blood pressure with age. Although it is realized that diet factors such as the daily intake of salt must be taken into account, the data nevertheless suggest that high blood pressure can develop in the presence of a life time low intake of salt and, vice versa, that a high salt diet is not incompatible with persistent low blood pressure.

In summary, there is a host of evidence suggesting that the culture in which people live not only influences their beliefs, attitudes and (social) behavior, but, by consequence, also their disease patterns. Marmot [65] considers four ways in which culture may affect disease patterns. Two of them obviously are equal to what we mentioned in the paragraph on social class differences. These are: (1) the cultural and social influences on behaviors and life style relevant to disease (e.g. smoking, use of alcohol, dietary habits), and (2) the traditional and institutionalized ways of mixing with other people, family ties, and the organization of social networks. Additionally, Marmot mentions the differences between cultures in what people recognize as disease [e.g. in Japan you may be hospitalized for unpleasantly smelling armpits, and amongst some South American tribes a particular skin disease (pinto) is so prevalent that not having it is considered an illness], and, finally, he emphasizes the importance of ecological relationships, e.g. the size, complexity, and development of a society. Similar to the sections on life styles and behavior and group differences, this kind of research seems very important to identify the specific health promoting and health damaging factors, and to derive principles which may be useful for the development of (especially large scale) intervention and prevention programs.

8. WORK AND ORGANIZATIONAL ASPECTS IN STRESS RESEARCH

Not only is much stress research devoted to unemployment and job loss, there is also a long tradition of research on the effects of both physical and social work conditions on somatic and psychological functioning. Ergonomics traditionally aims at adapting equipment, work space and environment to the human being. On the other hand, organizational psychology especially focuses on the social aspects of working: the relationship to colleagues and superiors, fitting aspirations and ambition to job content, etc. Thus, in addition to possible specific health adversities inherent to jobs such as pilot, firefighter, policeman, there are more general both physical and social aspects of work that can threaten the health of employees. It has been demonstrated that repetitive jobs of low complexity are associated with low self-esteem and lack of work satisfaction. In addition, results indicate that such work conditions are associated with absenteeism and with (psychosomatic) disease. A last thing to note concerns the outcome variable studied. Whereas in the approaches described above attention nearly always more or less explicitly was focused on health related variables, the outcome criterion in these studies often concentrates on productivity. Although it is realized that good health is an important determinant of productive functioning, it must not be underestimated that there are several other determinants which influence proper functioning in an organizational setting. Therefore caution is required if one wants to generalize findings from outside an organization to the inside and vice versa.

Within field research, the work stress approach has probably received the most attention, after life events research. In our opinion, this field offers some unique possibilities, which, however, until now are only partly exploited. The work setting, for the stress researcher has some interesting characteristics: generally, it is a relatively stable and well defined social and physical environment, and it fills a large part of life.

Below, we will discuss two aspects: (1) the relation between organizational aspects and individual problems, and (2) the effects of chronic (work) stressors.

Organizational aspects and individual appraisals

Work is mostly done in a social environment. Individual functioning is influenced by the social environment, and, vice versa, the social environment is influenced by the behavior of the individual. Therefore, the workplace is an unique ‘field-laboratory’ for studying the way social and organizational aspects are appraised and how this subjective evaluation process ultimately leads to different coping behaviors, and ultimately to different outcome variables.

These outcomes can be localized at the biological, psychological or social level. However, we feel that these opportunities are not yet completely utilized. Organizational stress research is dominated by transactional models and almost all studies are tied to a predominantly psychological level of analysis [66]. Consequently, organizational aspects are measured as the individual perceives them, i.e. independent of the objective characteristics. This process of appraisal is worth being studied in itself, but this can be done only when perception and objective organizational aspects are measured independently.

A further problem relates to the dominance of cross-sectional studies which makes it impossible to study the dynamics between individual and environment. The use of such designs may lead to an increased chance of an entangling of dependent and independent variables. What we obviously need is a process approach in which environmental and individual variables are measured independently and repeatedly. This problem probably is caused by the fact that organizational stress research is too ambitious and sets unrealistic goals: to relate organizational aspects and health consequences to each other. De Wolff [66] recommends concentrating on the relationship between organizational aspects and the psycholog-
The effects of chronic and uncontrollable stressors

Because of the nature of most work stressors, research in the workplace offers unique possibilities to study the effects of chronic stressors. Hardly any work or organizational stressor can be seen as an acute and time limited event; most stressors typically are enduring and mildly unpleasant situations, e.g., a disturbed relationship with superiors or colleagues, or physical constraints. The demands of the working setting often lay heavy restrictions on personal functioning. If the person is not able to do something to ameliorate the conditions (i.e., when active coping is not possible), he has to apply emotion focused coping strategies. This allows for the study of the effects of emotion focused coping on health and productivity. More important, however, is that such an analysis of the work setting may lead to insight into the dimensions that determine (un)adequate personal functioning and therefore may be helpful to apply effective interventions.

The studies by Frankenhaeuser and coworkers [68, 69] may be considered to be a good example of this. These investigators integrate methods and concepts from social psychology and psychobiology to study the effects of work stress. They not only try to identify aversive factors, but they also focus on psychosocial factors that may serve as protecting elements preventing harmful effects to occur. Their field studies yielded results very similar to those found in a laboratory setting: it was found that an active production-planning task was positively appraised and, at the physiological level was associated with increased adrenaline and decreased cortisol output. In contrast, a passive understimulating, supervisory control task induced subjective feelings of monotony and uneasiness. For this group, both adrenaline and cortisol were slightly elevated.

We think that this may illustrate that the work setting can be considered a ‘field laboratory’, where important aspects of the stress process can be studied in an unique way.

9. INTERVENTION AND PREVENTION

Intervention and prevention actions can be localized at three levels: (1) the individual; (2) its direct environment (housing conditions, working conditions, family structure) and (3) the macro-level (society in general, cultural factors).

At the first level a distinction can be made between (1) pharmacotherapy; (2) psychotherapy and behavioral techniques; and (3) physical therapy and exercise. Pharmacotherapy includes the administration of several drugs to relieve or alleviate symptoms. In addition to agents for specific somatic (e.g., digitalis or insulin) or psychological disturbances (tranquilizers, anti-psychotics) there is momentarily much interest for the so-called beta-blocking agents which may exert their influence both on the central and the peripheral level [70, 71]. Stress management techniques can be applied both as therapeutic procedures and preventive actions. To mention a few of the most important in this context: rational-emotive therapy, stress inoculation training and personality engineering, relaxation training and biofeedback. For a more thorough discussion of the available evidence the reader is referred to, among others, Woolfolk and Lehrer [72].

Recently, studies have been initiated to investigate the influence of a patient’s attitudes towards cancer on the immune function and, probably related, the course of the disease. The ultimate goal is to design a procedure that can be exploited therapeutically. Already about ten years ago the ‘visualization therapy’ was introduced by Simonton and Simonton [73]. This procedure, however, has been the subject of much debate. Hall [74] reviewed the use of hypnosis in the treatment of allergies. Although the results were not always consistent it was concluded that the possibilities of this approach deserve further study. Practically relevant also are the studies focusing on the interventions that may be useful both to shorten the period of recovery and to enhance its quality after having undergone medical procedures [75].

Relatively new is the interest of investigators for physical exercises as a potential technique to prevent stress related disturbances. It has been shown repeatedly that aerobically fit individuals may be capable of faster recovery in both physiological and subjective dimensions of emotionality [76, 77]. Moreover, there is strong evidence that physical activity and exercise can alleviate symptoms of mild to moderate depression and it also can reduce symptoms of anxiety [78]. Other evidence indicates positive effects on self-concept, confidence and mood [78].

At the second level one can think of family therapy, but also improving housing conditions, and work conditions. One must also not neglect physical stressors like noise or pollution. At the third level there is little to do in this respect. One cannot expect that the economical crisis and unemployment can be solved. Most important is that policy makers are penetrated by the fact that there is a problem called stress which costs the community a lot of money (estimates vary between 50 and 71 billion dollar a year in the U.S.A. [1]). Therefore, four important things have to be done: (1) provision of good health care services; (2) stimulation and promotion of health benefiting behaviors and life styles; (3) appropriate legislation to protect people from health hazard in working conditions; (4) provision of sufficient means to everybody to allow the purchase of the necessaries of life.

During recent years, there is an increasing interest for health promotion programs. In the section on life style and behavior we already pointed to the possible relevance of those findings for prevention. Yet, caution is needed for too optimistic expectations. In his critical overview, Kaplan [79] warns that “the expected health benefits from behavioral programs may not match the enthusiasm espoused by some health psychologists”. He discussed the following four assumptions on which the clinical practice of health promotion is based: (a) that behaviors can increase the risk of certain chronic diseases; (b) that changes in behaviors can reduce the risk of certain disease; (c) that behaviors can be easily changed; and (d) that behavioral interventions are cost effective. Reviewing the relevant literature, Kaplan states to be convinced...
of the most important contributions that the behavioral sciences may provide to health promotion, but he also realizes that a realistic evaluation of this contribution requires, among others, the integration of psychology and biomedical approaches and, especially, the willingness to collaborate. Given the assumption that behavior, both in the short and long term, can affect the health status of an individual (assumption a), this opens the way for an approach in which the individual himself is considered as being responsible for his health.

In that vision, disease is not something by which one is being overwhelmed, rather it is the more or less inevitable outcome of a process that is initiated and reinforced by one's own behavior. This view implies that it is important that people are impregnated with this message, in order to achieve that people feel themselves responsible in this regard. On the other hand, attention must be devoted to the more or less involuntary behaviors evoked by the confrontation with stressful encounters. It is here that specific stress management procedures may be effective not only to alleviate symptoms, but also to prevent similar problems in future upon a renewed exposure to stressful conditions. Although there are a number of initiatives in this field, what clearly lacks are evaluations of the programs. Some investigators [80] state that good and valid evaluation studies outweigh the costs of the health promotion programs with a factor 10, therefore the creativity of these same investigators must be activated to come up with some good alternatives.

CONCLUSION

This article wants to illustrate how stress research brings together investigators of several disciplines. The psychologist and the immunologist work closely together and so do the social epidemiologist and the cardiologist. In order to achieve the maximum result, it will be necessary that all these people do understand a common language: the language of stress research. We hope that this writing may contribute to the understanding between those working in the field of stress.

In addition to the above mentioned developments, there are some other important initiatives. Not only the increased willingness to collaborate is an important step forward; the same holds for the attempts to integrate field research and laboratory research. And, last but not least, the gap between animal research and human research seems to be bridged. These processes will stimulate the exchange of findings between researchers with different backgrounds, which, in turn, will benefit the quality of the ultimate outgrowth of the research efforts. In addition, we aim at a second goal. We hope that by reading this paper investigators are stimulated to question their approach and that they will realize the one-sidedness of a particular research strategy. Where are the boundaries of a certain approach? Where does 'personality' stop and 'life style' begin? Where does 'life style' stop and 'life event' begin? And what is this relationship with concepts as 'appraisal' and 'coping'? We feel that, in order to gain insight into the very nature of the stress process and their many different outcomes, such questions need to be answered.

Finally, we want to refer to Leventhal and Tomarken [81] who list five important shortcomings in human stress research: (1) the absence of random assignment to conditions; (2) the inability to elicit the components of the stress process and its moderators due to the absence of a comprehensive theory prior to the initiation of data collection; and, closely related; (3) the non-independence of the operations used to assess stressor, stress response and disease; (4) the inability to control or assess multiple levels of response (e.g. biological, psychological, and social); and (5) the lack of a time frame for plausible inference.

These authors also give recommendations and guidelines useful for stress research in future, which more or less easily can be met in practice. Stress: threat or challenge? This question not only may be posed in the light of the many different possible outcomes; it also seems relevant for those who want to study stress scientifically.

It will be obvious that, in order to fathom the stress phenomenon, both great efforts and creativity of investigators will be a necessary condition. Only the future can reveal whether it also will be a sufficient condition.

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