

Modern Approaches to Conceptualizing and Measuring Human Life Stress

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stressful life events, perceived stress, stress reactivity, HPA axis, allostasis, allostatic load

Abstract

The idea that adverse life circumstances and negative life events contribute to disorder and disease has long been held. Advances in conceptualizing and defining these conditions under the common label of life stress have led to progress in measuring both the environmental and individual response characteristics that may promote disorder and disease. In general, a substantial and growing research literature supports the basic premise that life stress plays an important role in the development of many psychological and physical problems. Recent research, too, strongly suggests that interest in life stress in relation to health and disease will accelerate over the coming years. Yet debates and controversies remain concerning how to best conceptualize and measure life stress, which presents distinctive challenges for advancing the field. The present review examines the major issues pertaining to these debates, controversies, and challenges, for they will be crucial to resolve if progress is to be made in understanding ways in which life stress may or may not contribute to psychological and physical disorders.

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INTRODUCTION

The concept of stress is inherently about an organism's adaptation to challenging environmental conditions over time. Since the early origins in research on animal and human physiology, stress concepts have sought to explain how the body (*a*) maintains core regulatory functions despite the continual, and oftentimes extreme, perturbations imposed by environmental events, and (*b*) what the psychobiological costs and consequences are of these dynamic regulatory processes. It was appreciated early on that stress involved diverse responses that were orchestrated across several levels of psychobiological functioning, an integrated "whole organism" reaction (Weiner 1992). In addition to the rapid

mobilization of energy substrates for immediate fight-or-flight physical action, the stress response recruits a larger network of central nervous system activities involving arousal, vigilance, cognitive processing, and memory (de Kloet et al. 2005, Gunnar & Quevedo 2007) and influences an extensive range of other metabolic and immune activities (Sapolsky et al. 2000). Broadly considered, stress encompasses adaptive demands from the molecular through the molar, from gene expression through social interaction.

Recognition of the different psychobiological levels participating in the stress response considerably enlarges the scope of inquiry. Contributions to understanding stress come from basic neuroscience and biology through psychology, epidemiology, sociology, and anthropology. Given such a broad and multilevel mandate for stress research, there have been diverse approaches to, and debates over, the most appropriate ways to define, conceptualize, and measure life stress. Noteworthy, too, is that interest in life stress has not been restricted to the research laboratory or to obscure scientific circles. Stress terminology in its many colloquial forms underpins and permeates popular explanations for diverse problems in health and well-being.

In this review, historical and background information pertinent to understanding current ideas about stress theory and measurement are presented first. Next, definitions of, and conceptual approaches to, life stress are discussed. Examining the relative merits of alternative views about stress assists in the subsequent task of evaluating current theoretical and measurement issues for studying life stress. Given the large range of approaches to measuring life stress, the review focuses upon the most common and the most promising methods employed in human field studies. As the reader will see, although progress has been made in theory and measurement of life stress, there are concerns about how well these advances are being incorporated into standard practices. Finally, although concepts and

findings from animal laboratory and human experimental and field research are drawn upon, the objective is to focus the review on theory and measurement of human life stress.

BACKGROUND CONSIDERATIONS

Many believe that stress is a problem of relatively recent origins, endemic to modern society and unrelentingly on the rise. There is a sense that, as a result of accelerating progress in science and society, life is inexorably moving forward at too rapid a pace, with a diminishing sense of personal security and control. The vocabulary of stress infuses everyday conversations, providing an idiom with rich subtexts to help explain away innumerable problems, ailments, and illnesses of unknown origins (Pohlman & Becker 2006).

It is important to recognize that this foreboding sense of stress is not a very recent development, and that stress is not necessarily an important cause of many disorders or diseases. People are very prone to mistakenly attribute problems of unknown origins to general and nonspecific concepts akin to life stress. The cultural practice of invoking stress as an explanation for disorders whose causes remain a mystery represents a serious challenge to progress in research on human life stress. Both investigators and research participants can be easily misled by unsubstantiated beliefs about life stress and its consequences (Monroe & Slavich 2007, Sontag 1978).¹

¹As Rees (1976) noted, the terms “stress,” “distress,” and “disease” appear on the surface to be simple and discrete. But as one traces their derivations and changing meanings over time, “they flow into each other and are closely connected” (p. 3). For example, “stress” was used in the fifteenth century as a shortened form of “distress,” whereas “disease” was initially meant to reflect “dis-ease” or discomfort (not illness), a form of distress. The terms remain rich with interconnected meanings, which likely contribute to many of the problems in research with regard to keeping concepts and measures separate and distinct.

CONCEPTUALIZING LIFE STRESS

Defining Stress

A variety of definitions have been proposed for stress. Despite numerous attempts, there remains no universally accepted characterization of the term. Separate research traditions have emphasized different facets of the general topic of stress. For example, human field studies and clinical observations have viewed stress as originating in the external environment (Dohrenwend 2000, Monroe & Roberts 1990). This “stimulus” perspective for defining stress typically assumes that environmental conditions are more or less likely to be stressful for the average individual, that stress is a probabilistic feature of particular environmental conditions. In contrast, animal laboratory research has frequently viewed stress as a particular psychobiological response of the organism to differing environmental challenges (e.g., the general adaptations syndrome, the fight-or-flight response) (Selye 1936, 1976; Weiner 1992). Within this response-based tradition, the environmental conditions eliciting the stress have been termed stressors (Selye 1976).

Although each of these approaches possesses merit, neither fully addresses a core feature of stress: the adaptation of the particular organism to specific circumstances that change over time. In other words, the stimulus and response viewpoints incompletely and only indirectly capture these three features of the construct (i.e., environment, organism, time). As others have explicitly recognized, stress is an intrinsically interactive and dynamic concept (Lazarus & Folkman 1984, Weiner 1992). The particulars of the organism, the environment, and time are all key elements of the concept. Consequently, it has been suggested that stress be defined in terms of an ongoing relationship between organism and environment (Weiner 1992) or as the successive transactions between the organism and environment over time (Lazarus & Folkman

1984). From this expanded viewpoint, the stress process is thought of in terms of external challenges and perceptions of the challenges, coping resources and perceptions of coping resources, and the dynamic interplay of these over time (Cohen et al. 1995b, Gunnar & Quevedo 2007).

There have been other attempts to capture the breadth, complexity, and spirit of “stress” over the years, and two conceptual developments have become influential in thinking about stress. These are (*a*) allostasis and allostatic load, and (*b*) psychological appraisal. Although these two topics derive from separate research traditions and levels of analysis (animal laboratory versus human stress research, psychobiology versus psychology of stress), they provide useful complements for one another. They remind us that stress involves adaptation from the most basic biological functions through the highest cognitive processes.

Allostasis and Allostatic Load

From animal laboratory research on psychobiological regulatory systems involving the stress response, there has been an increasing interest in how the stress response is orchestrated over time in service of adaptation. Since at least the work of Claude Bernard, ideas pertaining to the maintenance of the body’s internal milieu, and in particular to the regulatory concept of homeostasis, have been a prominent underlying principles of stress. In response to environmental changes and challenges, the organism maintained stability of key biological functions through homeostatic regulatory mechanisms. For example, set points for many vital bodily functions are maintained in balance and within strict limits through homeostatic controls. Within this tradition, stress has been viewed as external challenges that disrupt or impair/break homeostasis.

The concepts of stress and homeostasis, however, often have been used in ambiguous ways that have obscured possible psychobio-

logical implications for health and well-being (McEwen 2000, McEwen & Wingfield 2003). The concept of allostasis was introduced to bring greater clarity to these matters as well as to broaden and differentiate the range of psychobiological activities recruited in service of homeostasis and adaptation under stress. Theoretically, the concept of homeostasis has referred to the regulation of a limited number of core physiological systems that sustain life, systems that must be kept within tight limits (e.g., body temperature, pH balance). Allostasis, in turn, refers to how the organism achieves stability (or homeostasis) through continual change. It is a more encompassing concept, intended to incorporate an extensive range of whole-organism mechanisms recruited to meet environmental demands, all of which have more flexible set points designed to accommodate constantly changing environments and regulatory challenges (McEwen & Wingfield 2003, Sterling & Eyer 1988).

Allostatic load, in turn, refers to the consequences of sustained activation of primary regulatory systems serving allostasis over time, to the cumulative burden on bodily systems (i.e., wear and tear) that is believed to contribute to disorder and disease. The concepts of allostasis and allostatic load underpin a more comprehensive model of stress processes that may be useful for explaining why activation of these systems is adaptive over the short run and maladaptive over more prolonged periods of time. These concepts provide a richer and more differentiated framework of ideas to shed light on how stress response mechanisms are involved with the exigencies of the immediate flight-fight demands, in the short-term self-regulation and fine-tuning of these systems, as well as in their longer-term role in restoration and repair (de Kloet et al. 2005, McEwen & Wingfield 2003). The concepts of allostasis and allostatic load hold the potential to shed light on a range of current mental and physical processes conditions, some of which have only recently begun to be considered as potentially

stress-related (including key cellular biomarkers of aging; Epel et al. 2004, Sapolsky 2004).

Perception, Cognition, and Psychological Appraisal

A second major influence on stress theory came with the cognitive revolution and recognition that psychological processes intervene between the environmental event and the organism's response (Somerfield & McCrae 2000). Instead of stress involving reflexive responses to specific environmental challenges, the stress process expanded to accommodate a host of factors involving individual differences in perceptual processes and cognition. Increasingly complex and elegant theories evolved. These theories depict longitudinal transactions between the external demands of the environment, appraisal of the environmental demands, assessment of resources to handle the external demands, coping efforts to change the environment, and so on (Cohen et al. 1995b, Lazarus & Folkman 1984).

As a result of these fertile ideas, individual differences in psychological processes were elevated to key positions as intervening variables. Specifically, the appraisal of stressful situations and coping resources were accorded central significance for moderating how environmental challenges could affect psyche and soma. The hypothetical influence of appraisal could cut two ways: the impact of very stressful events could be attenuated, and the impact of more minor stressful events could be amplified (Kanner et al. 1981). Formulations such as these helped to explain why some people succumb more readily under stress than others. They also assuage underlying anxieties about the apparently random and relentless exposure to stress (i.e., if one can gain control over the consequences, one can control and perhaps eventually conquer the most noxious piece of the problem).

How pivotal and influential are appraisal processes for moderating stress impact? Arguably, this matter represents one of the most pressing considerations in contemporary re-

search on life stress. At one extreme, there is a relatively tight linkage between objective environmental stress and perceived stress. Indeed, it would seem obvious that perceptions are derived from the objective characteristics of the environmental context, the circumstances that lend themselves to perception (Monroe & Kelley 1995). From the broadened adaptive perspective of evolutionary theory, too, one would expect survival to depend upon a reasonable correspondence between the external demands of the environment and an organism's perceptions of those demands. Psychological factors and appraisal in particular remain relevant within this perspective, but the exigencies of the external environment largely contour and constrain psychological factors.

At the other extreme, there is a relatively loose linkage between environmental challenges and perceived demands. This extreme represents a strong psychological perspective, one in which cognition and appraisal dominate and significantly alter, override, or even reverse the influence of external circumstances. This perspective, too, is bolstered by popular motifs in cognitively oriented psychological science and practice (e.g., as the philosopher Epictetus averred, "Men are disturbed not by things, but by the view which they take of them"). Psychological factors and appraisal within this perspective are only partially constrained by the existing environmental exigencies. There are strong sympathies for this theoretical position, particularly in human life stress research (Lazarus & Folkman 1984, Lazarus et al. 1985).

The preceding discussion establishes that stress appraisal and cognitive processes are important additions to defining and conceptualizing life stress. The degree to which environmental challenges, the perception of environmental challenges, or the conjunction of the two contribute to stress and produce susceptibility to breakdown is presently unknown and is a pivotal topic for future research. The inclusion of cognition and appraisal to the stress model also poses challenges for

conducting research, particularly with regard to the measurement of stress (Monroe & Kelley 1995).

MEASURING LIFE STRESS

Given the breadth of the stress concept and the differing views as to its nature, it is no surprise that a variety of measurement approaches exist (see Cohen et al. 1995a). At a very general level, current approaches to measuring stress appear consistent with the three conceptual perspectives outlined above (the environmental component of stress, the response component of stress, and environment-person transactions of stress). However, many if not most measurement systems in practice blur these theoretical boundaries. For example, self-report life event checklists appear to fit most readily with an environmental definition of life stress. But when the study participant makes the decisions about which events qualify, or how stressful the events are, these measures inherently incorporate response components as well. Interview-based procedures for assessing life events, too, often estimate the likely impact of the life event on the participant or for the average person and thus include approximations of the person's response in the measure (Brown & Harris 1978, Dohrenwend et al. 1993).

A similar situation exists with response-oriented measures of human life stress. It is typically not possible to determine the degree to which variation in the particular response is due to external environmental conditions per se versus other individual difference variables that contribute to the stress process. For example, measures of perceived stress or cortisol levels may be a consequence of environmental stress but also may be moderated by such factors as personality or social support. Particularly of concern for response measures, too, is the degree to which the measure is actively confounded with the problem or disorder under study (e.g., depressed persons may report high stress or evidence elevated corti-

sol due to being depressed, not external stressors). Thus, response-based measures of stress pose significant challenges for separating the influences of stress from other factors, including the confounding with manifest disorder or psychopathology (Monroe & Kelley 1995).

Finally, the transactional definitions of stress have been more appealing in theory than evident in practice. There are few instances of empirical work in the literature based on such models (Folkman & Moskowitz 2004; cf. Stroebe et al. 2006). Keeping in mind these limitations for the different definitional perspectives on life stress, the following review of stress measures is organized around the most common practices used in the human literature on life stress.

Stressful Life Events and Difficulties Measures

The vast majority of studies of human life stress have assessed people's recent major life events. Since the idea of measuring life stress as discrete life events took operational form in the Schedule of Recent Experiences (SRE; Hawkins et al. 1957, Rahe et al. 1964), and with the addition of specific weightings for the SRE in the Social Readjustment Rating Scale (SRRS) (Holmes & Rahe 1967), attention to the topic has grown yearly. At present, over 10,000 publications beginning in 1967 have pertained to the topics of stressful life events or life stress (Dohrenwend 2006). Given the tremendous presence and influence of this general approach to the measurement of human life stress, as well as the ongoing debates about different measurement practices that have been spawned, the subject is covered in some depth.

The early procedures for measuring life events were based upon the precedent provided by the innovative SRE and SRRS. These and derivative self-report checklists included a range of life experiences that were considered to be relatively common in most people's lives and were assumed to require varying degrees of readjustment or, implicitly, stress. A clear

attraction of these measures was the ease with which one could apparently capture an objective index of something as complex as life stress. As in any area of scientific development, problems were soon uncovered with the first generation of self-report checklists, modifications were suggested, and a host of next generation measures were, and continue to be, developed (Brown & Harris 1978, Dohrenwend & Dohrenwend 1974, Dohrenwend et al. 1978, Monroe 1982, Paykel 2001).

Many early critics of self-report life event checklists, however, suggested that the problems with these measures were more basic, that they represented fundamental and possibly incorrigible limitations of the self-report checklist method itself (Brown 1974, Dohrenwend 2006).² Alternative systems for assessing life stress were developed, typically based upon information gleaned from structured or semistructured interviews (Dohrenwend et al. 1993, Hammen 1991, Paykel 2001). Perhaps the most elaborate and widely used system for assessing, defining, and rating life stress is the Life Events and Difficulties Schedule (LEDS), developed by George Brown and Tirril Harris (Brown & Harris 1978). The LEDS system includes an extensive manual that provides explicit rules and operational criteria for defining both acute and chronic forms of stress, for distinguishing between complex constellations of these forms of stress, and for rating these experiences using a comprehensive manual. These sources of information help guide decisions and enhance standardization of measurement. The unique biographical circumstances of the individual are taken into account when rating each life event; this helps to place the experience in context for that person, increasing the likelihood that the meaning of the event will

be captured in the rating. Approximately 5000 case exemplars are provided in the manual to also help anchor the assessment decisions and standardize the ratings. The LEDS information can be presented in a separate meeting to raters who are blind to the subjective reactions of the particular individual, in order to avoid confounding of the study participant's reaction with depression status (e.g., depressed individuals may evidence greater upset initially, or may report greater upset retrospectively to help justify or explain their depression).

A considerable body of research has now directly compared life event checklist measures with interview-based measures (e.g., Duggal et al. 2000; Gorman 1993; Katschnig 1986; Lewinsohn et al. 2003; McQuaid et al. 1992, 2000; Oei & Zwart 1986; Simons et al. 1993; Zimmerman et al. 1986). Although the procedures across these different studies vary with regard to the specific life event checklist and interview method used, the consistent finding is that there are significant differences in the information obtained between the two methods. For example, McQuaid et al. (1992) found that only 38.5% of life events reported with a self-report checklist corresponded with life events defined by the LEDS (Brown & Harris 1978). Lewinsohn et al. (2003) recently performed a similar comparison between self-report and follow-up interview methods. For life events primarily involving the subject, they found that 67.5% of events indicated on the checklist met the criteria for events according to their stress interview. For life events primarily involving other people, the correspondence rate was only 19.7%. Since life events primarily involving others were reported twice as often as events primarily involving the subject, the overall percentage of valid events as defined by the interview criterion was well below 50%. These findings are consistent with those of Duggal et al. (2000), who concluded that a checklist measure of life events captured only 32% of severe events occurring prior to depression onset.

These studies indicate that, even under the most optimistic circumstances, self-reported

²Much has been written on recent topics in life stress theory and research, so we only provide an overview of the issues that have been well detailed elsewhere. For more thorough expositions, we refer the reader to several excellent sources (Brown 1989, Dohrenwend 2006, Paykel 2001).

life events are consistent with the type of life event envisioned by the investigator less than half of the time. To be perfectly clear about this central matter, the likelihood of a life event reported by the study participant on a self-report checklist matching the life event defined according to interview-based criteria is generously, at best, even odds. As described below, these discrepancies do not reflect merely different opinions about the matter or alternative views; they typically reflect outright errors in the self-reporting of life events. The basic point is quite clear: Self-report checklist methods are very prone to errors in identifying life events. More generally, reviews of the life events literature are basically unanimous in concluding that interview-based measures are superior to self-report checklists, and that interview-based methods represent the current gold standard for assessing life stress (Dohrenwend 2006, Gorman 1993, Hammen 2005, Kessler 1997, Mazure 1998, Paykel 2001).

Many of the concerns about life events measurement echo across other research literatures. For example, "trauma" appears to be self-evident. On the surface, one might expect people to be relatively accurate and consistent in reporting exposure to a traumatic incident. Yet researchers investigating trauma have grappled with assessment problems essentially identical to those of life events researchers, and several reports have documented problems with self-report checklists for trauma exposure similar to those found with self-report life events checklists (Hepp et al. 2006, Roemer et al. 1998, Southwick et al. 1997). Different age groups experience different life events, too, and sundry self-report checklists of life events for children and adolescents have been developed that are susceptible to the same limitations as the adult life event measures (Grant et al. 2004). Finally, for many years survey research methodology has been dedicated to understanding factors affecting the subject's interpretation of questionnaire items and recall, factors that have effects that are often subtle, yet effects that

can substantially compromise the reliability and validity of the data obtained (see Schwarz 2007).

Three common themes cut across these related literatures that can help inform debate about appropriate methods for life stress measurement. The first theme concerns memory and recall of the essential information, the life events. How accurately can people remember past experiences and report on them? Somewhat surprisingly, with proper assistance and structuring of the questioning, people can accomplish this reasonably well. For severe life events using the LEDS system, it has been estimated that people can reliably report on such experiences for up to ten years (Neilson et al. 1989). Less severe events and more minor stressors, however, may be less reliably recalled (Brewin et al. 1993, Hardt & Rutter 2004). Current research on autobiographical memory provides clues on how to enhance the ability of individuals to recall life stress information reliably over extended periods of time (Belli 1998, Schwarz 2007). In principle, it would seem that these enhancements could improve both interview-based and self-report checklist methods for assessing life stress. Discrepancies between self-report and interview-based measures, then, are not likely to be explained by differences between the two approaches with respect to memory per se.³

The second and third themes are both related to the issue of recall, but more subtly so. And these two themes point to a critical divide between self-report and interview-based methods for measuring life stress. The first of these themes concerns the definition of, and decision about, what formally constitutes a life event. As Dohrenwend (2006) has recently systematically addressed, a major problem with self-report checklists is that people quite often interpret the life event descriptors in highly personal and idiosyncratic ways.

³It should be noted that when precise timing of event occurrences and onset of the disorder under study is required, more intensive questioning and assistance are needed.

Depending upon how the particular person interprets the question, the same life event descriptor can reflect a range of life events, from the trivial through the catastrophic. For example, serious illness and injury events can be endorsed for experiences involving a bad cold or minor sprain through heart attacks and major crippling accidents. This means that what the investigator intends to measure frequently does not correspond with what the subject actually infers and endorses (i.e., as noted above, correspondence is likely to be below 50% of the time). There is no common understanding of the spirit of the event between subject and investigator. This major shortcoming with life event checklists unfortunately has been repeatedly overlooked, minimized, or simply ignored.

Research on cognitive aspects of survey methodologies converges on this identical problem. As Schwarz (2007) notes regarding behavioral reports, "memory processes are only one of the determinants of their accuracy . . . respondents may report on a behavior that does not match what the researcher had in mind" (p. 283). This is where memory melds with the participant's current imperfect and evolving understanding of the task at hand. The participant's recall is structured by his or her own interpretation about what to search for. If the life event item is interpreted differently from the way in which the investigator intended, there will be a mismatch in understanding, error intrinsic to the data collected.

The third theme of relevance to this topic acknowledges that research participants draw upon a number of additional sources of information, background and contextual, to frame the task requirements, infer the investigator's intentions, interpret the information provided, and eventually come up with a response. Recognition of these multiple influences raises awareness about how readily stress measures are contaminated by extraneous information or confounded by subjective bias. Two major domains of influence are of particular concern (see sidebar). First, most

people who complete self-report checklists readily recognize that stress is of relevance to the study. Decisions about whether to endorse any of the listed life events are influenced by the participant's general views about life stress and specific inferences about the present research needs. This is one mechanism via which the cultural biases about stress can intrude and contaminate stress measurement, introducing random error. Second, people who have already developed problems, disorders, or illnesses may seek explanations for their maladies and be more prone to endorse life events that only vaguely resemble what happened to them (Brown 1974). Via this mechanism, awareness of the problem under study may confound stress measurement, resulting in systematic errors, which in turn promote spurious associations between life events and disorder. More generally, reliance on these uncontrolled background sources of information becomes most pronounced when there is no means for the participant to clarify the question, or to secure a better understanding, through discussion with a knowledgeable individual (Schwarz 2007). Thus, one of the main attractions of self-report life events checklists (i.e., expediency and minimal investigator burden) represents a fundamental limitation of the method.

The reliability data from the life stress research and information from related literatures consistently point to the serious shortcomings of self-report life event checklists. Given an estimated error rate for basic identification of life events with self-report procedures exceeding 50%, one can question the need for, or incremental value of, comparative validity studies. Nonetheless, there is a handful of studies with data bearing upon the matter. In general, the interview-based methods have been found to be superior in terms of associations with depression or depression-related phenomena (e.g., predicting greater depressive symptoms or lower probability of remission, McQuaid et al. 2000; detecting severe events typically found to precede depression onset, Duggal et al. 2000). In particular,

STRESS MEASUREMENT ERRORS RESULTING FROM MISINTERPRETATIONS BY RESPONDENTS

In previous research, we routinely interviewed people about life events they endorsed on a self-report checklist (McQuaid et al. 1992). Many times when we asked about what had actually happened, participants reversed themselves and indicated that it was probably an error (Monroe & McQuaid 1994). Interestingly, two types of false positive endorsements commonly occurred (people who indicated an event had happened to them, but with further information recognized that the experience did not qualify). First, there were people who had very few events but knew we were studying stress and felt that they should provide some relevant information on the topic. Upon questioning, these individuals quickly recognized that the endorsed items were not quite right, but they indicated that endorsed items were the closest they could come up with to provide us with some indicator of stress in their lives. Second, there were people who also had very few if any events, but upon questioning rather sheepishly and spontaneously indicated they did not want us to think their lives were boring. Both types of respondents stretched the definitions of particular events to satisfy the perceived needs of the research or to preserve respect in the eyes of the interviewer. The degree to which there may be a mismatch between the information sought by the investigator and the interpretation by the respondent can be astonishing. In these interviews following the completion of a life event checklist, we also inquired about events that may have happened but were not listed. In response to this query, one woman volunteered that her husband had recently suffered a heart attack. When probed as to why she might not have endorsed the life event item as "Serious illness in close family member," she indicated that the event wasn't stressful. As a result of his heart attack, her husband had quit smoking and perhaps become more patient, and they were getting along much better than previously. She was so strongly influenced by her assumptions about our interest in stress that she was able to override the rather clear and explicit question at hand and modify her response in line with what she thought we wanted.

interview-based measures are better suited for distinguishing between life events that are truly stressful versus trivial (Gorman 1993). It should be noted that self-report measures of life events on occasion have yielded asso-

ciations when compared with interview-based measures (e.g., McQuaid et al. 2000; see also Wagner et al. 2006). However, given the high error rate of event identification, concerns about the timing between stressors and disorder onset, and the problem of confounding between stress and disorder with such methods, the implications for stress-disorder relations are tenuous. Indeed, recommendations for the use of self-report checklists may be limited to a summary index of "overall level of subjectively experienced stress," with interview-based methods suggested for research on etiology (Duggal et al. 2000, p. 451).

In summary, research has repeatedly demonstrated serious shortcomings of self-report checklists of life events and chronic stressors as reliable and valid measures of life stress. Most of these problems can be addressed satisfactorily with semistructured interview-based approaches that utilize operational rules and guidelines for defining life events. There is an abiding faith in self-report checklists, however, as sufficient measures for some, or even many, research needs (e.g., an early life event scale, the SRRS, recently was declared to be "a robust instrument for identifying the potential for the occurrence of stress-related outcomes"; Scully et al. 2000, p. 875). And life event checklists continue, by far, to be the most common approach to assessing stressful life events. This indicates that other factors beyond empirical evidence influencing opinions in this crucial debate deserve greater attention. We return to this topic below in the Current Status, Controversies, and Debates section.

Perceived Stress Measures

In comparison with the literature on stressful life events, relatively few attempts have been made to measure perceptions or appraisals of stress (Monroe & Kelley 1995). The most common instrument of this kind in the literature, however, is the Perceived Stress Scale (PSS; Cohen et al. 1983). The PSS was developed based upon appraisal theory (Lazarus &

Folkman 1984) and was designed to "...tap the degree to which respondents found their lives unpredictable, uncontrollable, and overloading" (Cohen et al. 1983, p. 387). The original scale includes 14 items, and additional versions have been developed for 10- and 4-item subsets of the scale. All three versions possess good psychometric qualities [yet Cohen & Williamson (1988) recommend the relatively superior 10-item version]. The PSS is widely cited, used in diverse studies of life stress, and has been translated into several languages. Second to the generic life event checklist approach, the PSS is probably the most commonly used measure of stress in the research literature.

The PSS has been found to predict many adverse outcomes. Importantly, the PSS has shown discriminant validity with regard to life event measures of stress (i.e., each measure of stress predicts different stress-related processes or outcomes). For example, Cohen et al. (1993) reported that both perceived stress and stressful life events predicted greater risk for developing the common cold. However, these two measures produced different relations with illness and were mediated by different biological processes, suggesting that perceived stress and stressful life events measure different components of stress. Importantly, this suggests that measures of stress based upon the objective environment versus those based upon subjective appraisal relate to different underlying mechanisms, predict different aspects of illness, and in theory may be associated with different disorders or diseases.

As a general response measure of perceived stress, the PSS possesses the limitations previously discussed with response measures (i.e., the scale is influenced by a range of factors aside from environmental stressors). More specific and critical, too, is the obvious concern about overlap in item content between psychological symptoms and the PSS. Cohen et al. (1983) note this matter, reporting correlations of 0.76 and 0.65 across two samples with depressive symptoms. Yet in

other research, these investigators have shown the PSS to prospectively predict health outcomes independent of psychological symptoms (Cohen & Williamson 1988; Cohen et al. 1983, 1993), supporting the discriminant validity of the PSS with regard to psychological symptoms (Monroe & Kelley 1995). Overall, despite limitations inherent to stress response measures and cautionary concerns about confounding with psychological symptoms, the PSS possesses good psychometric qualities and a respectable record of validity studies (including noteworthy biological correlates; Epel et al. 2004, Gianaros et al. 2007).

The Psychobiology of Stress

Ever since early interest emerged in stressful phenomena, biological factors have provided a strong focal theme (Selye 1936, Weiner 1992). Animal laboratory and human experimental stress studies commonly incorporate biological indicators of stress responses; such measures have been employed far less frequently in human field studies of life stress. Yet there has been a steady growth of interest in the psychobiology of stress and resilience over the past decade (Dickerson & Kemeny 2004, Gunnar & Quevedo 2007, Hammen 2005, Sapolsky 2005, Southwick et al. 2005). In particular, the developmental neurobiology of the hypothalamic-pituitary-adrenal cortical (HPA) axis and the regulation of cortisol have become a major focus of interest for understanding individual differences in stress reactivity (Heim & Nemeroff 2002, Meaney 2001).

Considerable evidence across the animal, experimental human, and clinical human literatures suggests that early adversity contributes to alterations in neurobiological systems regulating stress, and in particular to HPA axis functioning (Heim & Nemeroff 2002). Alterations in these systems have been hypothesized to lead to greater sensitivity to environmental stress, and thereby to a greater likelihood of developing psychopathology, as well as other possible disorders (Gunnar &

Quevedo 2007). These sources of information nicely complement other areas of recent research, which have found strong general linkages between early abuse in childhood and a wide variety of adverse health outcomes in later life (Felitti et al. 1998).

There are important implications of these related research literatures for human life stress research. Theoretical frameworks and measurement practices can be expanded to incorporate early developmental abuses and adversities, along with their implications for psychobiological functioning and stress regulation. Recent advances in noninvasive measurement techniques, too, have fueled interest in the neurobiology of developmental stress research and provide the groundwork for shedding light on how environmental and psychological stress are biologically mediated (Gunnar & Quevedo 2007). However, the number of biological systems affected by stressful conditions is tremendous (Charney 2004, Southwick et al. 2005), and measurement issues are at least as paramount as are those encountered with other levels of stress research.

For example, studies on the HPA axis and regulation of cortisol are useful for understanding challenges to be considered (Dickerson & Kemeny 2004, Gunnar & Quevedo 2007, Miller et al. 2007). Although cortisol represents a logical indicator of stress impact involving key biological regulatory systems, standardized, consensually accepted methods for assessing the hormone do not yet exist. Significant obstacles to progress include basic questions about the nature of cortisol release (Young et al. 2004) as well as questions involving the particular methods of measurement. For instance, cortisol output can be assessed in different fluid systems of the body (e.g., saliva, blood, urine, or cerebrospinal fluid), which in turn vary in the amount of biologically active cortisol (unbound by carrier proteins) and in the temporal window during which cortisol is released (Miller et al. 2007). The circadian and ultradian rhythms of cortisol activity, too, further complicate optimal

measurement of the hormone (Young et al. 2004). Finally, cortisol may not signify a non-specific indicator of stress responsivity, but rather may be recruited in reaction to particular classes of environmental challenges (e.g., social or physical threat; Dickerson & Kemeny 2004, Miller et al. 2007). These cautionary points are raised not to dissuade efforts to relate psychological stress to biological correlates, but rather to acknowledge that other areas of stress research face difficult challenges in measuring indicators of the construct.

Overall, progress along these lines reaffirms stress as a whole-organism phenomenon. These ideas, too, are in keeping with recent recommendations for bridging the gaps between distal genes and proximal environmental factors through a systems approach that incorporates intermediate psychobiological processes (Caspi & Moffitt 2006, Gottesman & Hanson 2005). Although such work will no doubt add complexities for modeling and measuring the multiple components, such efforts will provide opportunities to anchor ideas about psychological stress more securely within a broadened and biologically plausible nomological network.

CURRENT STATUS, CONTROVERSIES, AND DEBATES

Scientific interest in life stress and its implications for health and well-being perhaps has never been greater (Cohen et al. 2007, Miller et al. 2007). In terms of neuroscience underpinnings, the concepts of allostasis and allostatic load are reinvigorating thinking about how adversity contributes to a host of mental and medical conditions. The range of biological processes involving stress is expanding, stretching toward physical conditions not previously viewed within a stress framework (e.g., metabolic syndrome, the aging process) (Miller et al. 2007, Sapolsky 2004). Advances in mapping the human genome and in developing molecular genetics techniques have set the stage for long-awaited breakthroughs

in understanding gene-environment interactions (Moffitt et al. 2005), with groundbreaking findings recently reported for an interaction between major life events and the serotonin transporter gene in clinical depression (Caspi et al. 2003). Overall, one can predict with confidence that even more attention will be devoted to life stress and its measurement over the next several years as investigators expand their efforts to understand the causes of diverse mental and medical problems.

Unfortunately, there are fewer reasons to be confident that the potential of life stress measurement to make meaningful contributions to these efforts will be fully realized. Although advances have been made in conceptualizing and measuring human life stress, these advances have not become part of established measurement practices. Despite the clear advantages of interview-based approaches to measuring life stress, Grant and colleagues (2004) recently estimated that fewer than 2% of 500 studies they reviewed on stress in children and adolescents used interview-based procedures. Most of what is accepted as satisfactory measurement of stress is simply not in keeping with what is now well documented about scientifically sound measurement practices, or with what is recommended by experts in careful reviews of the literature. As biomedical fields develop increasingly sophisticated and cutting-edge assessment technologies, progress on life stress measurement has at best plateaued (or flatlined).

When it comes to conceptualizing and measuring life stress, a curiously casual and uncritical attitude characterizes much of the research literature. Oftentimes stress measures are improvised for the immediate undertaking, with little regard for the larger literature on assessing life stress or even for reporting basic psychometric information. The manner in which the final stress score is operationalized, too, is highly inconsistent, and often unique, across studies (e.g., total life events, total negative life events, subjectively weighted life events, events selected from a

particular life domain). The lack of attention to standardized practices, despite their availability, has resulted in setbacks along several lines. Replication is not possible when primitive and diverse methods are used across studies. Falsification of hypotheses based on life stress is a problem when there are few constraints upon what passes for "stress," when there is a smorgasbord of seemingly endless operational opportunities from which to draw (Monroe & Reid 2007).

Finally, without reliable means of establishing replication or refutation of stress hypotheses, there is little direction or guidance for developing better ideas and stronger measures. This may be the most incapacitating result of these problems. The gold standard for assessing life stress is the LEDS, and this venerable measure is now over three decades old (Brown & Harris 1978). The PSS, too, has now been in existence for a quarter century (Cohen et al. 1983). These represent very long periods of time within the continually evolving world of science. New developments are needed to advance the field and to meet the anticipated demands of the next decade and beyond for stress research.

One way forward is to gain a better understanding of the reasons for the present impasse. Why is there such a permissive and uncritical attitude toward measuring life stress? In the following section, we speculate on several factors that may explain this current state of affairs in human life stress research. Through bringing these issues to the forefront of discussion, it is hoped that the standards for stress measurement can be raised, and new approaches may be developed, in pursuit of clarifying the role(s) stress may or may not play in disorder and disease.

Subjectivity, Individuality, and Measurement

Many theorists and researchers have a strong inclination to view the participant's perceptions as the deepest and most meaningful truth about the stressfulness of the situation.

Without this level of phenomenological insight into the experience, it is believed that measurement will be stripped of individuality and thereby stripped of what likely constitutes the essence of stress. Whom but the person experiencing the event can ever speak to, or appraise, how stressful it was? By not allowing the participant to express his or her feelings about the issue, the uniqueness of the individual is not honored or respected, and the most insightful source of information is ignored.

Admittedly, this is a caricature of the issue, intended to magnify a subtle, but possibly substantial, source of prejudice. The point touches on a sympathetic chord that insidiously undermines the credibility of investigator-based approaches to assessing life stress, of approaches trying to standardize measurement of the environmental conditions characterizing stressful encounters. Somehow having the respondent supply his or her own subjective views, untainted by investigator interference, is assumed by many to permit a more profound understanding of the truth about stress to emerge. Many simply believe what is central is the view the person takes of the situation, not the situation itself (which, as noted, remains an important empirical question). These attempts at preserving the sanctity of the subjective self, however, ignore the inescapable reasons already discussed for not naïvely relying only on what the respondent has to say casually about his or her recent life experiences.

When the questioning is properly structured, when there is ample opportunity for “collaborative cognition,” and when clarification about the information can be sought (Schwarz 2007), study participants can provide reasonably reliable information about the life experiences involved. Details of the experience that are of importance for estimating the likely personal meaning of the event, too, can be obtained (i.e., the contextual ratings of the LEDS system; Brown & Harris 1978). One should not confuse the necessary task of eliciting essential personal information

from the respondent with the equally necessary and separate task of making standardized judgments about the information so obtained.

Costs, Requirements, and Compromises

One point of agreement across all perspectives on stress measurement is that interview-based procedures are more costly and time consuming and thereby less suitable for investigations requiring large samples (Dohrenwend 2006, Hammen 2005). Although these are important limitations of the method, they do not de facto legitimate the use of self-report checklist methods. These are quite separate matters.

Often life stress is one factor among many in a multifactorial design, with stress ranging in importance from a primary cause through a trigger, a contributor, or only a complication. When stress is only part, or a relatively minor part, of the working model, even the most conscientious investigator may feel pressure to adopt methods that are more expedient. But does measuring stress poorly make sense, even if other factors in the model are measured with fidelity? Alternatively, the research agenda may require very large numbers of individuals, and resources are insufficient to support interview-based measures of life stress. But measuring stress with large numbers of people doesn't make poor measurement any better, and it doesn't translate into good science in any obvious way (especially with serious concerns about confounding factors). Worthy of mention, too, is the large increase in statistical power afforded by precise and reliable measurement; employing the best measures of life stress can thus reduce the required sample size (Moffitt et al. 2005).

More generally, the concern is that these expedient precedents build upon themselves, and the literature proliferates with measures that then provide perceived credibility for the inferior approach. Recall that as little as 2% of the research literature may be based on preferred measurement approaches (Grant

et al. 2004). As Gorman (1993) pointed out, in other areas of scientific inquiry, “the choice of method would probably be made according to which technique seemed most promising in terms of advancing knowledge” (p. 72). Many areas of psychology require costly and time-consuming assessment procedures but do not suffer from the same begrudging attitude about the time, expense, and technical requirements entailed.

A compromise position might be to adopt measures of perceived stress when time and resources are limited and to avoid self-report life event checklists altogether. As noted above, the PSS and similar measures have their limitations, yet proper control procedures and research designs can help offset many of these concerns. For example, controlling for psychological symptoms increases confidence that associations with perceived stress are not attributable to confounding with existing symptoms. By also employing prospective designs, the investigator can help assure that variation in stress precedes and predicts the later-occurring outcome of interest. The PSS, too, has the added attraction of being relatively transparent with respect to its advantages and disadvantages and of having an extensive research record for comparative purposes (see also Cohen et al. 1995a). Self-report life event checklists are too easily overvalued and misleading, providing an illusion of accurate stress measurement despite extensively documented unreliability (Dohrenwend 2006).

Stress as a Self-Contained Nonspecific Explanation

It is worth considering whether something about the concept itself contributes to the uncritical attitude about how to measure life stress. The idea of stress possesses such compelling face validity and cultural reification that investigators may be blinded to thinking more critically about its measurement. Two aspects of this admittedly speculative idea are worth considering.

Quite commonly, studies that report stress for some adverse outcome do not take the logical next step to question what it might be about stress that accounts for the findings. There tends to be a lack of curiosity about what it “is” about stress that leads to harm. After one accepts the basic premise that stress is associated with some negative outcome, attention shifts to other aspects of the research or elements of the causal model. Researchers rarely probe the inner workings of stress (e.g., questioning whether the situation involves physical threat, loss, danger, or humiliation) or the possible underlying mechanisms (e.g., negative affect, rumination, or neuroendocrine dysregulation). Even the critical question of what proportion of the stress process can be accounted for by the objective environmental versus subjective appraisal is seldom considered. In a strange and circular way, stress seems to stand on its own as a plausible, complete, self-contained explanation.

The face validity of stress not only deflects attention away from the inner elements of the stress concept, it also allows attention to be drawn to tangentially related factors. Life circumstances that can be connected in some way with the generic idea of stress are readily entertained, easily accepted, and uncritically incorporated into the nonspecific construct. Once these remotely related factors are somehow connected to stress, they then snap to the defining grid of the construct. And, as noted above, the need for further explanation then ceases.

Recent research on life stress and the serotonin transporter gene in depression provides a good example of this loose mode of transitive thinking. The original report by Caspi et al. (2003) used preferred interview-based methods to assess life events. Studies attempting to replicate the original findings, however, have used stress measures ranging from indices composed of chronic diseases, unemployment, and physical distress (with no life events; Grabe et al. 2005) through a composite including a questionnaire on social problem solving, parental education, and

total life events (Eley et al. 2004). Although 12 replication studies had been conducted at the time this review was written, investigators (Monroe & Reid 2007) had identified only one that employed interview-based life event methods (Kendler et al. 2005). Once again, the intuitive appeal and face validity of life stress helps to understand how such diverse phenomena are uncritically united and interchangeably employed under the common stress rubric. The field needs to move away from this misleading mode of thought and adopt a more critical attitude about what qualifies as life stress and how it is to be measured.

CONCLUSIONS AND FUTURE DIRECTIONS

Theory and research on life stress and its implications for health and well-being have produced a wealth of promising findings over the past several years. In one form or another, life stress has been found to predict a wide variety of psychological problems and medical conditions, ranging from acute infectious diseases (e.g., the common cold) through chronic medical disorders (e.g., coronary heart disease) (Cohen et al. 2007, Miller et al. 2007). Future studies will need to move beyond generic associations between life stress and disorder to address increasingly specific questions about what acute or chronic forms of stress, under what circumstances, lead to particular disorders or diseases.

Controversy and debate, however, have surrounded the optimal ways to conceptualize, and in particular to measure, human life stress. Despite repeated calls for increased rigor in the measurement of stressful life events, a wide recognition of the limitations of self-report checklists, and the availability of better measures (e.g., the LEDS or PSS), the self-report checklists continue to predominate (Brown 1989, Dohrenwend 2006, Grant et al. 2004). Studies are needed to identify stress measures that can provide reliability and

specificity and that are able to illuminate particular dimensions of stress and their implications for health. For example, acute forms of stress such as stressful life events may be relevant for the onset of certain conditions (e.g., major depression), whereas chronic forms of stress may be informative for diseases that have a more protracted and insidious onset (e.g., coronary heart disease). More generally, measurement systems for future research should be capable of distinguishing between different qualities of life stress to permit more fine-grained analysis in relation to different disorders (see examples in Brown & Harris 1989).

Research on life stress and physical disease, too, raises the intriguing possibility that effects for objective indicators of environmental stress and subjective indicators of stress appraisal operate via different mechanisms and possibly contribute to different outcomes (e.g., Cohen et al. 1993). In addition to these main effect distinctions worthy of further examination, the interaction between the objective demands of the external environment and the subjective perceptions of the persons requires greater research attention (Monroe & Kelley 1995). For instance, individual differences in stress sensitivity may explain why some people break down under high stress conditions and others do not, as well as why other people develop disorders under apparently minimal environmental provocation. Integrating these two perspectives on objective and subjective stress measures will again require methods capable of reliably measuring the two facets of stress and making such distinctions. Finally, given that life stress represents a whole-organism response, the inclusion of genetic information and biological indicators will afford a framework of inquiry allowing investigators to probe the ways in which external and perceptual stress processes affect key biological processes and systems, which in turn create the vulnerable conditions that can lead to disorder and disease.

DISCLOSURE STATEMENT

The author is not aware of any biases that might be perceived as affecting the objectivity of this review.

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Errata

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