The 1990s were declared by Congress to be the "decade of the brain." This declaration is important to all psychologists, not only neuroscientists, because with this declaration come expectations of the cognitive and behavioral sciences generally and because the brain does not exist in isolation but rather is a fundamental component of developing and aging individuals who themselves are mere actors in the larger theater of life. This article examines the importance of a multilevel, integrative approach to the study of mental and behavioral phenomena in the decade of the brain, reviews how this approach highlights the synergistic relationship between theoretical and clinically relevant research, and illustrates how this approach can foster the transition from microtheories to general psychological theories.

My concern is that the character of psychology is increasingly manifest in the rapid proliferation of narrowly focused and compulsively insular camps, a proliferation that seemingly knows no limits. (Bevan, 1991, p. 475)

Panoramic photographs of earth from space reveal agricultural runoffs that stretch hundreds of miles out to sea and vast clouds of fossil fuel emissions blanketing industrial areas. These disquieting images reflect the collective action of individuals, but the effect of these actions cannot be fully appreciated unless these phenomena are studied from a point of view that extends well beyond the level of individual actions. From this ionospheric perspective, one could easily visualize effects that could not be fully comprehended from a closer focal point. This simple example from space science illustrates a principle that seems so obvious in the physical sciences but that often appears incomprehensible in the psychological sciences and neurosciences. There are phenomena that may be explicable in terms of events at a microlevel of analysis but that are more easily studied and more fully comprehended by reference to broader and multiple levels of analysis.

Our aims in this article are to outline the importance of a multilevel, integrative approach to the study of mental and behavioral phenomena in the decade of the brain; to review how this approach highlights the synergistic relationship between theoretical and clinically relevant research; and to explore how this approach might foster the transition from microtheories to general psychological theories. We begin by examining the decade of the brain and its relevance to the social and psychological sciences. We then review several psychological principles underscoring the thesis that basic research cutting across levels, including the cultural, social, psychological, and biological, is an imperative rather than a luxury if the decade of the brain is to produce satisfactory answers to complex psychological phenomena and disorders.

Decade of the Brain

A fundamental assumption in the natural science of psychology is that neurophysiological processes underlie adaptive and maladaptive psychological phenomena. William James (1890/1950) was one of the first psychologists to articulate this assumption; to recognize that developmental, environmental, and sociocultural factors influence neurophysiological processes underlying psychological phenomena; and to acknowledge that these influences could be studied as neurophysiological transactions. James also asserted that unnecessary diseconomies and conundrums would result if neurophysiological events were the exclusive focus of psychological investigations (Cacioppo & Tassinary, 1990a).

William James drew these conclusions over a century ago. In decades past, studies of the neurophysiological...
structures and functions associated with psychological events were limited primarily to animal models, post-mortem examinations, and observations of the occasional unfortunate individual (e.g., Phineas Gage, H.M.) who suffered trauma to or disorders of the brain. Developments in electrophysiological recording, brain imaging, and neurochemical techniques within the neurosciences have increasingly made it possible to investigate the role of neural structures and processes in normal and disordered thought in humans. The importance of these technical developments was underscored by Congress’s declaration of the 1990s as the decade of the brain.

The congressional declaration of the decade of the brain is important to all psychological sciences for two reasons. First, this declaration may confer higher appropriations, but it clearly confers higher expectations for the unraveling of the mind’s knots and nightmares. The credibility of the cognitive, behavioral, and social sciences, not just the neurosciences, is therefore at stake.

Second, the brain does not exist in isolation but rather is a fundamental but interacting component of a developing or aging individual who is a mere actor in the larger theater of life. This theater is undeniably social, beginning with prenatal care, mother–infant attachment, and early childhood experiences and ending with loneliness or social support and with familial or societal decisions about care for the elderly. In addition, mental disorders such as depression, schizophrenia, and phobia are both determined by and are determinants of social processes; and disorders such as substance abuse, juvenile delinquency, child and spousal abuse, prejudice and stigmatization, family discord, worker dissatisfaction and productivity, and the spread of acquired immunodeficiency syndrome (AIDS) are quintessentially social as well as neurophysiological phenomena. Social psychology, with its panoramic focus on the effects of human association and the impact of society on the individual, is therefore a fundamental although sometimes unacknowledged complement to the neurosciences.

The importance of a social psychological perspective to the neurosciences is revealed in research demonstrating both that (a) neurochemical events influence social processes and (b) social processes influence neurochemical events. Studies of mating behavior in the ring-necked dove, for instance, indicate that social behaviors (e.g., male strutting and cooing) trigger hormonal changes (e.g., increased production of estrogen in the female) that predispose the female toward a new set of behaviors (e.g., courtship and copulation), which results in yet additional reciprocal influences between hormones and social behaviors until the newborns are reared (Erikson & Lehman, 1964; Lehman, 1964; Martinez-Vargas & Erickson, 1973). These reciprocal influences have also been found in primates. Testosterone levels in male primates, for example, have been found to promote sexual behavior, whereas the availability of sexually receptive females, in turn, has been found to influence testosterone levels in male primates (Bernstein, Gordon, & Rose, 1983; Bernstein, Rose, & Gordon, 1974; Rose, Gordon, & Bernstein, 1972; see also, Davidson, Camargo, & Smith, 1979). Indeed, our understanding of the function of hormones would be far more rudimentary if not for analyses of their effects on social behavior and for the effects of social behavior on hormonal changes. Thus, comprehensive theoretical accounts of hormonal regulation (not just sexual behavior) necessitate consideration of social factors. There are, of course, physiological mechanisms underlying these phenomena, but the identification and understanding of these mechanisms are better served by systematic investigations within and across multiple (including social) levels of analysis rather than by a reductionistic focus alone.

The differences in social psychological and neuroscientific levels of analysis have occasionally obscured commonalities and isolated related research on and contributions to a psychological phenomenon. Before considering these commonalities and potential mutual contributions, we will review briefly ways in which the term level of analysis has been used in social psychology and in the neurosciences. We will then define how the term will be used here, review several basic principles in which the construct of levels is fundamental, and examine the implications of these principles for psychological theory and research.

Level of Analysis: Single Level Versus Multilevel Analysis

Single Level Analysis

The term level of analysis has been used in psychology to refer to the level of structural organization (e.g., Tolman, 1959; P. Weiss, 1941), the level of explanation (e.g., Shaw & Turvey, 1981), and the level of processing (e.g., Churchland & Sejnowski, 1988; Craik & Lockhart, 1972). In the present article, we will focus on the first usage of the term levels, which refers to the different scales into which the brain or behavior can be represented. What constitutes a level of organization, at least for lower mechanisms, is usually guided by knowledge of anatomy or physiology; but the ultimate criterion is the usefulness of the posited organization in shedding light on some designated biological, psychological, or behavioral phenomenon. Thus, the level of organization of psychological phenomena can vary from the molecular, to the cellular, to the tissue, to the organ, to the system, to the organism, to the physical environment, to the sociocultural context.

1 We chose to focus here on social psychological contributions to the decade of the brain for two reasons. First, its complementarity to a neuroscience perspective is less understood than other psychological perspectives. Cognitive, behavioral, and developmental neuroscience, for instance, are all active areas of research, but social neuroscience strikes some as being an oxymoron (see Scott, 1991). It is not, as we hope to illustrate in this article. Second, the social and neuroscience perspectives represent two ends of a continuum of levels of organization studied in psychology. By illustrating the importance of considering both social and neuroscience perspectives and their intersections, we hope to illustrate the general importance of multilevel, integrative analyses of complex psychological phenomena.
Levels of analysis in the neurosciences generally encompass the lower end of this spectrum, whereas in social psychology they capture the higher end—the individual and group within a sociocultural system. Thus, these fields differ in the level at which behavioral phenomena are unitized, although they need not differ in terms of the behavioral phenomenon under investigation. For instance, although both neuroscientists and social psychologists may study sexual behavior, aggression, or addiction, the elements into which the phenomena are partitioned and the dimensions of the measurements of these two levels of analysis are discordant. Consequently, the conceptual units and dimensions of one level seldom map isomorphically into those of another. This lack of isomorphism is inherent across levels of analysis because (a) higher levels entail functional outcomes of interactive aggregates of lower processes and (b) a given outcome may arise from differing aggregates or states. Thus, social psychological analyses focus on social structures and processes that characterize functional aspects of neurophysiological mechanisms, but a particular function cannot be readily characterized in the terminology and concepts of neurophysiology. Moreover, a given function can be implemented by one or more neurophysiological mechanisms whose boundaries may not be obvious, at least initially, from anatomical considerations (Cacioppo & Tassinary, 1990b; Fodor, 1968).

**Multilevel Integrative Analysis**

Important advances have been made and will continue to be made using single levels of analysis. Indeed, one of the themes of this article is that such research is important and bears on issues relevant to investigators working on the same psychological phenomenon even when their particular level of analysis is quite different. We suggest there is an additional benefit to be gained, however, from a multilevel analysis of the phenomenon, wherein one considers not only the elements from two or more levels of analysis that bear on some phenomenon but also the relational features among these elements. Thus, by multilevel analysis we mean the study of a phenomenon from various structural scales or perspectives, ranging from the neuroscientific ("microscopic") to the social psychological ("macroscopic"). By integrative, we mean simply that analyses of a phenomenon at one level of organization can inform, refine, or constrain inferences based on observations at another level of analysis and, therefore, can foster comprehensive accounts and general theories of complex psychological phenomena. Given differences in the unitization of a phenomenon across levels of analysis, multilevel analyses require special considerations, which we will consider below.

There are at least three reasons to expect that multilevel analyses of complex social and behavioral problems will be integrative. First, complex systems as a rule cannot be understood as a simple extrapolation from the properties of their elementary components (Marr, 1982). Unless the properties of the system are the simple sum of those of its elementary components, a focus on elementary components contributes to an explanation only when considered in conjunction with events occurring at different levels of the system. Indeed, Fodor (1968; Fodor & Pylyshyn, 1988) observed that there are causal structures at each level of organization and that the causal structures at the macroscopic level in science cannot be predicted by the microscopic. 2

No one expects the theory of protons to look very much like the theory of rocks and rivers, even though, to be sure, it is protons and the like that rocks and rivers are "implemented in" (Fodor & Pylyshyn, 1988, p. 63). Fodor and Pylyshyn further noted:

Clearly it is pointless to ask whether one should or shouldn't do cognitive science by studying 'the interaction of lower levels' as opposed to studying processes at the cognitive level since we surely have to do both. Some scientists study geological principles, others study 'the interaction of lower level units' like molecules. But since the fact that there are genuine, autonomously-stable principles of geology is never in dispute, people who build molecular level models do not claim to have invented a 'new theory of geology' that will dispense with all that old fashioned 'folk geological talk about rocks, rivers, and mountains' (p. 66).

For this reason, the study of the elements of a system (i.e., reductionism) may produce eloquent descriptions while falling short of a useful and comprehensive explanation.

We should emphasize that we are not suggesting that the study of the behavior of elementary components has disutility or is irrelevant to molar analyses but rather that reductionistic inquiries can precede (or co-occur or follow) and, in turn, stimulate (or be informed by) relatively molar research on the behavior of complex systems. The example from space science with which we began this article is a case in point. The study of the system as an aggregate may produce detailed descriptions of the molar behavior of the system while falling short of defining the underlying origins of this behavior (i.e., individual and collective actions in the case of the pollution). Learned helplessness exemplifies a molar psychological phenomenon that was subsequently informed by, and in turn informed, lower levels of analysis. Early research demonstrated that inescapable shock led to a depressive syndrome characterized by inactivity, loss of escape/avoidance reactions, and a decrease in reactivity to pain (Seligman, 1975). This research led to a specific psychological explanation that ascribed this state of helplessness to the learning of a lack of contingency between responses and outcomes and to a pessimistic attributional style (Abramson, Seligman, & Teasdale, 1978; Peterson & Seligman, 1984). Research in the neurosciences, however, has further demonstrated that (a) brain catecholamine

---

2 Fodor's (1968) emphasis was on concepts and theories rather than elements (units, dimensions). Differences in the unitization of a phenomenon across levels of analysis and the consequent lack of isomorphism become even more notable when one progresses from elements to conceptual or theoretical schemata that must also specify relational features among dissimilar and nonisomorphic elements.
depletion can yield a similar syndrome, (b) inescapable shock can lead to a decrease in central catecholamines
and an opiate-mediated analgesia, and (c) this syndrome
may be effectively treated by antidepressants or other
agents that enhance central catecholamines or block opiate
receptors (Basbaum & Fields, 1984; Bodnar, 1990; Maier,
1984, 1986; Simson, Weiss, Hoffman, & Ambrose,
1986; J. M. Weiss, Goodman, Losito, Corrigan, & Bailey,
1981; J. M. Weiss et al., 1986). Thus, lower levels of anal-
ysis have illuminated physiological mechanisms that may
underlie this helpless syndrome and in turn may in-
form certain cases of human depression (Maier, 1984;
J. M. Weiss et al., 1981). On the other hand, it has also
become apparent that (a) there are both associative and
nonassociative behavioral determinants of helplessness
(Lysle & Fowler, 1988; Maier, Jackson & Tomie, 1987;
Minor, Doss, & Overmeir, 1991; Seligman, 1975), (b) the
degree of stress-induced catecholamine depletion is re-
lated to the psychological factors of predictability and
controllability (Maier, 1984; J. M. Weiss et al., 1981), and
(c) physiological mechanisms for both opiate and non-
opiate stress-induced analgesia are differentially invoked
on the basis of the behavioral context (Bodnar, 1990;
Maier, 1986, 1989). These reciprocal interactions between
behavioral and physiological domains would seriously
cloud studies limited to a single level of analysis. The
point is that distinct levels of analysis might better be
viewed as complementary rather than alternative ap-
proaches. The relationship between catecholamine de-
pletion and depression in helplessness, for instance, did
donot originate in research on central catecholamine
regulation but in research on the effects of uncontrollable
stressors on behavior and cognition.

A second reason multilevel analyses of complex so-
cial and behavioral problems tend to be integrative is that
each level of organization constitutes a particular kind of
representation with which to examine human mentation
and behavior. Any particular representation makes certain
information explicit at the expense of other information
and, hence, renders some operations or insights easy and
others quite difficult. Thus, no single level of behavioral
organization is best for all psychological questions. An
example can be found in the relative utility of specifying
the sociocognitive versus the neurophysiological basis
of patient delay following the onset of gynecologic cancer.
Women can now survive most gynecologic cancers if
the disease is diagnosed and treated early. Indeed, research
on gynecologic cancer indicates that the prognosis for
survival and for quality of life following medical treatment
is directly related to the stage of the cancer at diagnosis
(Andersen, 1986). Moreover, women with advanced rather
than early-stage disease at diagnosis, even if they survive,
are more likely to suffer depression, experience marital
and family problems, and require extended and expensive
medical treatment. Hence, patient delay in seeking a di-
agnosis is a serious problem that carries large and long-
term personal, family, and societal costs. The form of the
representation of patient delay offered by neuroscientific
analyses of patient delay, although perhaps ultimately
contributes to a more complete understanding of the
phenomenon, is not optimal for identifying the deter-
minants of patient delay or for developing effective in-
terventions to minimize such delay. Huge savings in re-
sources and human suffering are there to be reaped, not
through a specification of the brain circuits underlying
patient delay but by well-conceived public health cam-
paigns that identify the early signs of cancer and minimize
the material, emotional, and social costs of seeking di-
agnosis and treatment (Andersen, 1986; see also Rossi,

Third, Fodor and McLaughlin (1990) noted that
precision is often gained when one moves from general-
izations about operations on molar elements to general-
izations about operations on microelements. However,
this increased precision does not yield a truer depiction
of the causal mechanism nor is the conceptual price paid
for the precision necessarily worth the gain in precision.
As Fodor and McLaughlin noted, if by moving to the
more microscopic level of analysis one finds the macro-
level processes are not really causal, then it must mean
the microlevel processes underlying these macrolevel
processes are not causal either. Moreover:

We get still more precision when we go down from unit-sensitive
operations to molecule-sensitive operations to quark-sensitive
operations. The moral is not, however, that the causal laws
of psychology should be stated in terms of the behavior of quarks.
Rather, the moral is that whether you have a level of causal
explanation is a question, not just how much precision you are
able to achieve, but also of what generalizations you are able to
express. The price you pay for doing psychology at the level of
units is that you lose causal generalizations that symbol-level
theories are able to state. (Fodor & McLaughlin, 1990, p. 204)

Thus, if some designated set of neural events is a
sufficient cause for a psychological phenomenon, the ef-
ffects documented in experimentation in which the des-
ignated events are manipulated will be replicable. The
illusion of generality may be achieved by the study of the
behavior of simple systems rather than complex phe-
omena because of the replicability of an effect across
laboratories worldwide. However, although lawfulness is
established when a psychological phenomenon (e.g.,
aversive conditioning) is invariably affected by the ma-
nipulation of a specific neurophysiological system (e.g.,
lesions of the amygdaloid nucleus; see LeDoux, Iwata,
Cicchetti, & Reis, 1988), generality is not established. Only
if these neural events are also a necessary cause are the
effects fully generalizable. If the designated events are
sufficient but not necessary to produce the psychological
phenomenon (e.g., the psychological phenomenon is
multiply determined by independent sets of neural
events), experimental manipulations of the designated
events may reliably produce the psychological phenom-
emon only because other sufficient causes have been con-
trolled in a particular experimental paradigm or assess-
ment context. In such cases, a “generalizing problem”

---

3 It is rare for a single factor or determinant to assume a necessary and sufficient relationship with a complex psychological phenomenon.
is to be expected in natural (e.g., clinical) settings or populations. A well-known example can be found in the research on the physiological detection of lying. Although lying about a significant event typically produces an electrodermal response, efforts to detect lying on the basis of electrodermal responses are characterized by high false-alarm rates unless the myriad other sufficient causes of electrodermal responding have been controlled in the assessment procedure (Iacono & Patrick, 1988). From this point of view, the generalizing problem does not reflect a methodological quagmire but rather represents a theoretical challenge. That is, the observation that effects documented in carefully controlled experimentation lack generalizing power may not reflect any dubious feature of experimentation or particular level of analysis but may simply reflect the multiply determined nature of the phenomenon of interest. Thus, boundary conditions for theories can be identified and new theoretical organizations can be discovered when generalizing problems arise. In this light, reductionistic studies demonstrating the sufficiency of a neurophysiological mechanism as a cause of some psychological phenomenon are immensely important, largely because they guide and constrain general theories of the psychological phenomenon.

**Doctrine of Multilevel Analysis**

We have suggested that multilevel analyses spanning neural and social perspectives can foster comprehensive accounts of psychological phenomena. The doctrine of multilevel analysis states that there are psychological phenomena that derive from events at one level of analysis and that are only or more distinctly observable across levels of analysis. Consequently, order can uniquely emerge when psychological phenomena are examined from multiple levels of analysis.

The doctrine of multilevel analysis specifies that microanalyses of a psychological phenomenon can be particularly effective when pursued in addition to or in conjunction with molar analyses. It also holds a key argument for maintaining psychology as a coherent scientific discipline. Scott (1991) reflected on what he viewed to be the inevitable fractionation of psychology as a scientific discipline, with the growing abyss, for example, between the fields of social and biopsychology: "Most biopsychology students consider a core course in social psychology to be an impediment toward becoming a neuroscientist. . . . I assume that our students in social psychology reflect that sentiment about their core experience in biopsychology" (p. 975).

Methodological fractionation may be inevitable with the maturation of the subdisciplines in psychology. Furthermore, the expansion of basic empirical data and theory within these subdisciplines increases the difficulty of mastering the methods and theories of multiple levels of analysis. The doctrine of multilevel analysis makes it equally apparent, however, that the inevitable consequence of this fractionation is a devolution into fact lists and elaborated microtheories with limited generality. The demand for general theories of psychological phenomena may therefore be better served by at least a rudimentary training of graduate students in multiple subdisciplines within psychology and by forming multi-investigator research teams working together to bring differing levels of analysis to bear on a psychological problem.

The doctrine of multilevel analysis is composed of three principles and a corollary:

1. The principle of multiple determinism: A target event at one level of organization (e.g., neuroeffector response, evaluative response predisposition) may have multiple antecedents within or across levels of organization.

2. The corollary of proximity: The mapping between elements across levels of organization becomes more complex (e.g., many-to-many) as the number of intervening levels of organization increases.

3. The principle of nonadditive determinism: Properties of the collective whole are not always predictable from the properties of the parts until the properties of the whole have been clearly documented and studied across levels.

4. The principle of reciprocal determinism: There can be mutual influences between microscopic (e.g., biological) and macroscopic (e.g., social) factors in determining brain and behavioral processes.

An example of the principle of multiple determinism can be found in the extensive literature on drug abuse. It now seems clear that endogenous brain opioid receptor systems constitute ultimate bases for the physiological, cognitive, and affective actions of opiate drugs of abuse. Studies of these systems have illuminated, and will continue to clarify, the underlying dynamics and physiological consequences of drug self-administration. However, central opioid systems are common across individuals, only some of whom will succumb to drug abuse. Hence, central opiates merely constitute permissive substrates for substance abuse. The proximate and powerful determinants of drug abuse include the social factors of economics.

---

(4) If a psychological phenomenon is multiply determined by synergistic variables that coexist in the laboratory but not typically in nonlaboratory settings, then a generalizing problem will again be encountered. The resolution of this generalizing problem will again rest on insight into the multiply determined nature of the psychological phenomenon.
opportunity, peer group influences, and family dynamics. These determinants will not be understood at an exclusively neuroscientific level in the near future. Rather, the interactions between social processes and the underlying neural substrates that support drug administration represent some of the most important issues currently facing our society. As is so often the case, it was the molar features of a phenomenon that prompted and guided inquiry into underlying mechanisms. Indeed, it was the profound psychological effects of the opiates and their abuse potential that stimulated research leading to the discovery of central opioid systems.

Considerable additional evidence has amassed over the past several decades demonstrating that elements in the physiological domain and elements in the psychological domain can be influenced by a multiplicity of factors within and across levels of organization (e.g., see Plomin, 1989). Consideration of these sets of factors can foster more comprehensive theoretical accounts than are achievable by limiting empirical and theoretical inquiries to the factor with the largest effect size or to a single level of analysis. This can be illustrated by returning to our example of drug (e.g., alcohol) abuse. An understanding of osmoreceptive mechanism and volume detectors, which monitor body water balance, can offer an eloquent account of facilitated ingestive reflexes, and the action of alcohol on central gamma-aminobutyric acid (GABA) receptors may constitute a partial explanation for its incentive value. These mechanisms, however, offer only a partial account of an animal bar-pressing for water, for which the principles of learning must be invoked. Nor do they tell us much about the drinking behavior of alcoholics in bars, which is heavily determined by social and contextual factors. Conversely, even extensive studies limited to operant performance or barroom behavior would be relatively uninformative about the fundamental mechanisms of thirst or alcoholism if conceptualized in isolation of the psychobiological underpinnings. Studies of the opiate system and addictive behavior, for example, have shown that drug administration results in opiate receptor changes, which in turn contribute to drug tolerance and addiction, which in turn contribute additional drug administrations, opiate changes, and so on. However, whether or not these developments result in a positive feedback loop and drug addiction depend also on the individual's social context. Clearly, research that specifies the conditions under which each of a set of factors or processes is operative, and that specifies the relationship between empirical observations at differing levels of analysis, sets the stage for integral theoretical advances.

A supplement to the principle of multiple determinism is the corollary of proximity, which states that the mapping between elements across levels of organization becomes more complex (e.g., many-to-many) as the number of intervening levels of organization increases. This is because an event at one level of organization (e.g., depressive or schizophrenic behavior) can have a multiplicity of determinants at an adjacent level of organization (e.g., cognitive), which in turn may have a multiplicity of implementations at the next level of organization (e.g., neurophysiological), and so forth. The implication is not to avoid venturing across the abyss separating the macroscopic and the microscopic levels of organization but to proceed incrementally across levels of analysis. These measured efforts can pay handsome dividends. As illustrated in research on learned helplessness (see above), understanding a behavioral problem at multiple levels of organization can result in a more general theory and can improve the selection and application of clinical interventions.

The principle of nonadditive determinism further highlights the order in behavioral data that can emerge when one uses a multilevel analysis to examine a phenomenon. According to this principle, properties of the collective whole are not always predictable from the properties of the parts until the properties of the whole have been clearly documented and studied across levels (Marr, 1982). Consider an illustrative study by Haber and Barchas (1983), who found that the administration of amphetamine appeared to have no reliable effect on primate behavior until the primate's position in the social hierarchy was considered. When this social factor was considered, amphetamine administration was found to increase dominance behaviors in primates high in the social hierarchy and to increase submissive behaviors in primates low in the social hierarchy. The importance of their study derives from their demonstration of how the collective, physiological changes on behavior can appear unreliable until the analysis is extended across multiple levels of organization. A physiological analysis, regardless of the sophistication of the measurement technology, may not have unraveled the orderly relationship that existed between the physiological manipulation and behavior. There are, of course, physiological mechanisms underlying these phenomena, but the identification and understanding of these mechanisms are often better served by systematic investigations within and across multiple (including social) levels of organization than by a reductionistic focus alone.

The evidence for the principle of reciprocal determinism further establishes the complementarity between social psychological and neuroscientific levels of analysis. Reciprocal determinism between biological and social factors is, of course, inherent in evolutionary analyses of social species. More interestingly, Plomin (1989) reviewed evidence in behavior genetics that suggests a wide variety of genetic influences are repressed unless or until certain environmental factors are introduced. Within social psychology, Zillmann (1984, 1989) has demonstrated that violent and erotic material influences the level of physiological arousal in males and that the level of physiological arousal has a reciprocal influence on the perceptions of and tendencies toward sex and aggression. As discussed earlier, testosterone in male primates promotes sexual behavior, and the availability of sexually receptive females influences testosterone levels in male primates (Bernstein et al., 1983; Rose et al., 1972). Testosterone affects aggressive as well as sexual behavior, and increasing the
level of testosterone in a castrated chimpanzee leads to behaviors by the primate that elevate his social rank (Clark & Birch, 1945; see also, Bernstein, Rose, & Gordon, 1974). In addition, alterations of social rank influence testosterone levels. In an intriguing naturalistic investigation, for instance, Jeffcoate, Lincoln, Selby, and Herbert (1986) obtained repeated plasma samples from five men confined on a 38-foot boat during a 14-day sailing holiday around the north coast of Scotland. The men were physicians and were used to having blood samples taken. One of the five men surreptitiously recorded dominance/aggressive behaviors (e.g., bossiness, insistence on undertaking "important" tasks) to document the social hierarchy that emerged over the course of the holiday. Results revealed that the remaining four men had comparable testosterone levels before and after the holiday. Nevertheless, by the end of the second week on the boat, the individuals who had achieved the highest rankings in the social hierarchy also exhibited the highest testosterone levels, whereas the least dominant pair had the lowest levels of testosterone (see also Keverne, Meller, & Eberhart, 1982). Of course, the reciprocal determinism between biological and social systems cannot be mapped if either level of organization is regarded as irrelevant, and achieving comprehensive accounts of the role of these systems in behavior is difficult in the absence of a mapping of their mutual influence.

It follows from each of the foregoing principles that an exclusive focus on a reductionistic (e.g., neurophysiological, molecular, genetic) level of analysis can mask contributions of other levels of organization to mental order and disorder and thereby constrain theoretical accounts of psychological phenomena. This supposition is apparent in research on the putative role of dopamine systems in schizophrenia. The hypothesis that excessive dopaminergic activity underlies schizophrenia was developed in part from correlative evidence linking the clinical efficacy of antipsychotic drugs with their ability to block dopamine receptors (Losonczy, Davidson, & Davis, 1987; Seeman, Lee, Chau-Wong, & Wong, 1976). Evidence that dopamine antagonists (neuroleptics) produce improvements in schizophrenic behavior has led to interpretations ranging from dopamine's being a "marker" of schizophrenia to the dopaminergic system's representing the mechanism responsible for the disorder. The fact that elevated dopamine levels produce autonomic and behavioral effects similar to those found in schizophrenics (e.g., Zahn, Rapoport, & Thompson, 1981) does not necessarily imply that the emergence or maintenance of schizophrenia is invariably (or even usually) initiated by excessive levels of dopamine. Indeed, dopamine abnormalities may not be present in all cases (Haracz, 1982; Losonczy et al., 1987; Meltzer, 1987). Thus, (a) the dopaminergic system may represent but one of many physiological mechanisms capable of producing schizophrenia; (b) dopamine may be one of a complex of biochemical variables in which subsets (coalitions) are capable of generating schizophrenia; or (c) an overabundance of dopamine is not an antecedent of schizophrenia but rather, like schizophrenia, a consequence of some other underlying process (Patterson, 1976; Spohn & Patterson, 1979; Zahn, 1986). However, the processes underlying schizophrenia may be best conceptualized and investigated across levels of analysis. For instance, there is no longer any doubt about the importance of genetic, social, and environmental events in triggering schizophrenia (e.g., Turpin, Tarrier, & Sturgeon, 1988). It is also clear that environmental stressors that can exacerbate schizophrenic symptoms exert powerful modulatory influences on central neurochemical systems (including dopamine). Clearly, the ultimate explication of the bases of schizophrenia will require attention to interactions between genetic and environmental factors and multiple central neurochemical systems.

In summary, the predictable yield from isolated research on discrete determinants of a multiply determined psychological outcome is a portfolio of fact lists and disparate microtheories. Each of these microtheories provides a limited account for the phenomenon of interest, however, and is at best a piece of a larger conceptual puzzle. Even determinants of a phenomenon that account for a modicum of variance are noteworthy if the goal is to achieve a comprehensive theory of the psychological phenomenon rather than a microtheory of the determinant. In addition, knowledge of the body and brain can usefully constrain and inspire concepts and theories of psychological function, insomuch as there are any number of ways in which a particular outcome might be achieved. Knowledge about the functional organization of ordered and disordered mental activities, however, can also usefully guide the study of the underlying brain processes, because the nature of the particular physiological mechanisms and events could be suggested by the observed mentation, behavior, or interaction. Although there are neurophysiological processes that are affected, for instance, by human association and that underlie the associated psychological and social phenomena, these phenomena shape physiological events in ways that may not be evident from studies of the physiology isolated from the social or environmental context in which they manifest. Hence, without attention to basic social psychological factors and processes, the decade of the brain may yield some spectacular images and experimental effects but rather limited answers to the problems of mental health.

Social Neuroscience?

We have thus far reviewed principles of behavior that underscore the theoretical utility of examining complex psychological phenomena and mental disorders from multiple levels of analysis. Although Bevan (1991) and Leshner (1991) have suggested that investigating the processes underlying mental health from multiple points of view may be the look of the future, it is not entirely new to social psychology. As Gordon Allport (1968) noted: An individual is a member of many publics, of many institutions, of many social systems. . . . It was Sapir who advised all social
and psychological scientists to form the habit of looking at their
data both from the concrete individual point of view and from
the abstract social point of view. It enriches research and theory
to do so. (p. 55)

Social psychological contributions to the neurosciences are particularly apparent in, and served as the im-
petus for, the explosive development of the field of psy-
choneuroimmunology. Classically, immune functions
were considered to reflect specific and nonspecific phys-
iological responses to pathogens or tissue damage (Roit, 
Brostof, & Male, 1985). It is now clear that immune
responses are heavily influenced by central nervous pro-
ces that are shaped by psychological factors (see reviews
Indeed, effects of psychological context now appear to be
among the most powerful determinants of the expression
of immune reactions. It is clear that an understanding of
immunocompetence will be inadequate in the absence of
considerations of psychosocial factors. Research on these
interactions was activated by research demonstrating the
direct and moderating effects of psychosocial factors (e.g.,
conditioned stimuli, bereavement, social support, major
life events) on immune competence (e.g., see Kennedy et
al., 1990). Thus, major advances in the neurosciences
can derive from increasing the scope of the analysis to
consider the contributions of social factors and processes.

Our more general theme throughout this article,
however, has been that reciprocal benefits and more gen-
eral psychological theory can be achieved by considering
or pursuing jointly macrolevel and microlevel analyses
of psychological phenomena. Social psychological con-
tributions to the understanding of complex, multiply de-
termined mental processes and problems may be limited
unecessarily in scope to the extent that a parochial per-
spective is adopted by neuroscientists or by social psy-
cologists. To illustrate, consider social psychological re-
search on attitudes, which has produced a large corpus
of data and theory, much of which can and has been
applied to the study and resolution of mental problems
(e.g., see Cooper & Aronson, 1992; Petty & Cacioppo,
1986). Theories of attitudes and attitude change, however,
have only infrequently considered physiological factors
and mechanisms or research on appetitive and defense
motivational systems. Evaluative categorizations and re-
sponse predispositions—criterial attributes of the con-
struct of attitudes—are fundamental and ubiquitous in
behavior. Mechanisms for differentiating hostile from
nurturing environmental stimuli are imperative for the
survival of species and for the formation and maintenance
of social units. Indeed, all organisms have biological
mechanisms for approaching, acquiring, or ingesting cer-
tain classes of stimuli and withdrawing from, avoiding,
or rejecting others (Berntson, Boysen, & Cacioppo, in
press; Cacioppo, 1991). Knowledge of the organization
and operating characteristics of these underlying mech-
nisms may therefore lay down, at least in broad strokes,
the rules by which biological and social factors alter eval-
uaive categorizations and evaluative response disposi-
tions. Protective flexor–withdrawal reflexes to pain stimuli
are apparent, for example, even in the isolated spinal cord,
and both decerebrate humans and rats display stereotyped
orofacial ingestion/ejection reflexes to relevant gustatory
stimuli (Grill & Berridge, 1985; Steiner, 1979). Although
of constitutional origin and generally stereotyped in form,
reflective responses nevertheless demonstrate a sensitivity
to motivational variables. Orofacial ingestion reflexes can
be primed by metabolic deficits and can be modulated by
conditioned taste aversions, even in the decerebrate
organism (Berridge, 1991; Grill & Berridge, 1985). These
inherent dispositions allow an organism, even at early
stages of development and without previous experience,
to adaptively respond to important classes of environ-
mental stimuli.

There is an enormous additional adaptive advantage
when an individual member of a species is also able to
acquire new evaluative response dispositions (e.g., atti-
tudes) toward the stimuli in its particular environment
as a consequence of the contingencies in that environ-
ment. Thus, adaptive reflexes are functionally limited,
but they represent only a single level in what appears to
be a continuity of evaluative mechanisms (Berntson et
al., in press; Cacioppo, Petty, & Berntson, 1991). Although
decerebrate organisms display orofacial ingestion/ejection
responses to gustatory stimuli, they do not evidence nor-
mal appetitive goal-seeking behavior (Berntson & Micco,
1976; Grill & Berridge, 1985). With the involvement of
additional subcortical structures, such as the limbic sys-
rem and striatum, the reactions of the decorticate animal
to pain stimuli entail additional response components
and evidence greater directedness, integration, serial co-
herence, and contextual adaptability (Berntson & Micco,
1976; Goldstein & Oakley, 1985). Furthermore, the
ingestive behavior of the decorticate is more fully re-
sponsive to metabolic signals, and appetitive or goal-
seeking components are apparent. These findings suggest
that evaluative mechanisms are not localized to specific
neuraxial levels but evidence a hierarchy or representation
throughout the central nervous system. With progressively
higher organizational levels in evaluative mechanisms,
there appears to be a general expansion in the range and
relational complexity of contextual controls and in the
breadth and flexibility of adaptive response (Berntson et
al., in press; Cacioppo et al., 1991). Although research
on the interactions between evaluative mechanisms at dif-
fering levels of the neuraxis is still in its early stages, there
appears to be considerable common ground for dialogue
between social psychologists and neuroscientists.

In summary, reductionism has contributed to the
solution of some of the most perplexing scientific prob-
lems in human history (e.g., see Boorstin, 1983) and has
much to contribute to our understanding of social and
psychological phenomena. However, it is counterproduc-
tive to presume that reductionism will convert the ab-
stractions of the psychological sciences to "real" science
in the coming millennium, just as it is counterproductive
to presume that reductionism produces insights that are
irrelevant to theories of social processes and phenomena.
To do either ignores the distinction between levels of ex-
planned, the scientific breakthroughs that can result from research at each of the levels of explanation and at or across levels of organization, the rich theoretical insights about the nature and timing of the relationships among variables that can be derived from descriptions of phenomena from multiple scales or perspectives, and the economy of thought to be reaped by capitalizing on the form of representation most appropriate for the task. In addition, it undermines multilevel, integrative analyses; alienates scientists working at "unchosen" levels of organization who might otherwise contribute relevant data and theory; and renders it acceptable to ignore relevant theory and data on a phenomenon of interest simply because they were not born from one's own level of analysis. Given there are phenomena that derive from events at one level of analysis that are only or distinctly observable at other or broader levels of analysis, then multilevel integrative analyses will play an important role in providing the empirical data and theoretical insight needed for a comprehensive understanding of basic behavioral processes, mental health, and mental disorders. Thus, the decade of the brain is more likely to be a gateway to a new millennium of the mind if we recognize that the brain is a single, pivotal component of an undeniably social species and if we recognize that the nature of the brain, behavior, and society is, in Bevan's (1991) words, orderly in its complexity rather than lawful in its simplicity.

REFERENCES


Keverne, E. B., Muller, R. E., & Eberhart, A. (1982). Dominance and


