Receding horizons of health: biocultural approaches to public health paradoxes

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Abstract

Worldwide challenges to health reflect a “paradox of success,” whereby both the strengths and the weaknesses of current approaches in public health, epidemiology, and biomedicine have determined the nature of the health problems we now face. In detail, we analyze and illustrate five constituent paradoxes that fuel continued health risk even in the face of success, including: (1) unmasking, (2) local biology, (3) socialization, (4) emerging and reemerging disease, and (5) savage inequity. We trace the pathways behind the paradoxes and their effects on health, and demonstrate that biocultural dynamics are involved in each. Furthermore, we track the roots of health paradox to changes that divert or disrupt pathways for production of health. These analyses contribute to an emerging literature of research and praxis on integrative biocultural models of health.

Keywords: Population health; Mental health; Social epidemiology; Health policy; Epidemiologic transition

1. Introduction

After a century of successive global transformations in mortality and morbidity schedules, new challenges to health have arisen to erode the vision of progressive disease eradication and health security. Clearly, new paradigms are required to secure and advance prior gains, which have been achieved through application of potent but ultimately limited paradigms in biomedicine and public health (Susser & Susser, 1996a,b). The situation arises in part because the very success of those paradigms has left behind intractable health challenges. These challenges are on the rise, and established measures are proving ineffectual. Previous successes capitalized on getting beneath the skin of biology or society to identify and then target specific domains of physiology or of epidemiology that underlie disease processes and health risk. Analysis of the reasons for past successes can help identify the sources of our present difficulties. In this essay, we take up the present challenge to reconsider the bases of human health in light of these challenges, to inform reformulations of biomedical and public health praxis by examining the conundrums confronting health.

2. Unexplained variance in health outcomes

Although the importance of social processes and cultural factors for health has been recognized, theorized, and actively investigated over the previous century (Hacking, 1990; Hahn, 1999; Krieger, 2001; Paul, 1955), epidemiologic demonstrations of association have outstripped specification of the proximal pathways that make the link from context to differential health outcomes. The
gap is understandable, given the conceptual and logistical challenges of the multifactorial research required to track such pathways (but see Luthar, 1999; Singer & Ryff, 1999). Yet the need to address that gap has become recognizably more acute as formal approaches and reductionist models are tapped out (Kaufman & Cooper, 1999; McKinlay & Marceau, 2002). Despite their statistical and heuristic value, epidemiologic approaches are recognizably dwarfed by often substantial unexplained variance in health outcomes, particularly in social epidemiology. The same is true of patient outcomes in clinical and biomedical research. Although probability models may substantially contribute to residual variance (Finch, 2000), models that are statistically significant nevertheless routinely leave unexplained variation in incidence or case outcomes on the order of 80%. Indeed, residual variation less than 50% is considered excellent explanatory power, and it is not uncommon for residual variation in complex biopsychosocial models on large data sets (such as in historical or in developmental epidemiology of mental health risk) to reach 98–99% (Allen, 2000; Bailar, 2001; Coe, 1997; Costello & Angold, 1995). That just 2–60% of variation in health outcomes can be explained with our statistically “successful” explanatory models and interventions indicates the extent of residual variance in health that remains to be understood, and signals the presence of other, significant factors and dynamics that require our attention.

For instance, in a large, longitudinal, population-based study of development in children and adolescents in western North Carolina (Costello et al., 1996), multiple physical, contextual, and experiential factors (e.g., family function, demographics, life events) were assessed along with psychiatric outcomes. Such data allowed identification of global as well as specific risks for psychopathology (e.g., Angold, Costello, & Worthman, 1998; Costello, Angold, March, & Fairbank, 1998; Costello, Keeler, & Angold, 2001). Unsurprisingly, we found strong relationships between number of risk factors (poverty, social adversity, family risk) and psychiatric status of youth: as risk factors increased (Fig. 1), rates of psychiatric disorder rose exponentially, such that prevalence rose to 33% among those with numerous risk exposures. Nevertheless, Fig. 1 shows two other important facts: children with no exposure to identifiable risk still had a 5% prevalence of disorder and, even more remarkably, only 33% of children at the highest levels (≥7 risks) of risk experienced disorder. By implication, two-thirds of children managed to remain free of psychiatric illness despite very heavy burdens of risk. The fact that they do so also requires explanation, for the causes may be quite different than those for children with pathology.

Some have sought to tackle unexplained variance by shifting from the predominant emphasis on vulnerability and risk, to consider resilience and protection (Davidson, 2000; Luthar & Cicchetti, 2000). Resilience, unlike vulnerability, emphasizes positive rather than negative health outcomes; as defined in a recent critical review, it comprises a “dynamic process encompassing positive adaptation within the context of significant adversity” (Luthar & Cicchetti, 2000). Resilience, moreover, is not merely the flip side or statistical residuum of risk, for different active forces can be involved that generate health or resilience and are relatively independent of (though they may interact with) risk-generating processes. Indeed, an additive ecological view proposes that resilience, and hence health, are generated through individually negligible but cumulatively definitive processes in everyday life (Masten, 2001). By this view, customary health practice involves fostering endemic pathways to health as a goal in itself above and beyond taming or treating pathology (Anthony, 2001). We need greater specificity about these processes and pathways to formulate the next generation of paradigms for the social production of health.

In the following discussion, we analyze five paradoxes underlying current challenges to global health with regard to their biocultural bases, impact on health, and relationships to resilience. Common and distinctive features of the paradoxes will be sought to identify important remaining barriers to health and the trade-offs involved in their resolution. Such integrated biocultural analyses are needed to develop new models for health.

3. Receding horizons of health

The root sources of threat to global health partly arise from a paradox of success: recent, dramatic advances in
human survival and health are endangered by challenges to health unleashed by those very successes. The hydros of ill heath fuel the call for population and preventive health approaches. Amelioration of health problems amenable to interventions such as sanitation or antibiotics, has evoked yet more complex health challenges and resulted in receding horizons of health. Resolution of the paradox requires revision of public health practice and its underlying conceptual frameworks in biomedicine, epidemiology, and social science. We note at the outset that primary threats to health also reside outside population and biomedical health praxis, rooted in macro-structural, economic, sociopolitical, and demographic conditions and change, or failure to change, in such conditions (Dasgupta, 1993; Gwatkin, 2000; Sen, 1992; Wilkinson, 1996).

The paradox of success actually comprises a set of paradoxes that drive the receding horizons of health. We address five current paradoxes.

- Changes in morbidity patterns have resulted in the phenomenon of unmasking that accompanies the epidemiologic transition. Whereas infectious disease previously dominated survival, especially at early ages, chronic degenerative diseases and mental illness at later ages now comprise a significant proportion of impairment and mortality. Consequently, factors contributing to risk or conferring resistance to chronic illnesses have come to play a more important role in determining health outcomes. Thus, the components most important for resilience or health maintenance have also shifted during the epidemiologic transition.

- Advances in the biomedical sciences have built on universalized models of physiology and pathogenesis. However, an expanding literature accentuates the importance of local biology, by documenting that biological function and regulation may differ widely based on local context and developmental history. Population genetics plays only a small role in this variation, which reflects instead the impact of environmental conditions on development and function, from gestation onward. Limitations in universal health interventions such as vaccination underscore the need to address local biology.

- Even when we stand equipped with the knowledge and technology to improve health, structural and cultural factors can impede their implementation. Socialization of disease has thus led to different outcomes for HIV/AIDS between African and Western nations, as well as variable success among African countries. The social dynamics of resilience manifest most strongly in this domain, as does the impact of social change that can either erode or enhance hitherto unrecognized factors moderating vulnerability.

- The resurgence of diseases previously lowered in prevalence combined with the yearly barrage of newly identified infectious diseases additionally slows our progress to global improvements in health. Changing demographics, international travel, altered land use, and microbial evolution contribute to the paradox of emerging and reemerging disease. These diseases forcibly remind us of the powerful synergy between human behavior and the evolution of pathogens.

- The inability to sustain positive developments in health and the failure of other interventions illustrate the need for significant changes in the distribution of resources to address the final paradox, savage inequity. Savage inequity connects poverty to inequality and inequity under conditions of escalating resource disparity despite extreme human resource extraction. Savage inequity compounds the results of commission (producing inequity produces health risk) with those of omission (failure to equalize resource access and thus enhance resilience) and illustrates the power of human ecology to shape health risk.

The paradoxes of successes are clearly interrelated, though we tease them apart for analytic purposes. Synergy among paradoxes produces some of the most serious and refractory challenges to health (as in the case of HIV/AIDS) by exacerbating vulnerabilities and exposures through multiple pathways embedded in behavior and social structure. Analogously, the means for their resolution would have a synergistic effect on resolving the root causes of ill health as well.

4. Unmasking

Abatement of formerly prominent sources of morbidity/mortality has altered the relative importance of specific health problems and revealed a residuum refractory to previous treatments. Dramatic increases in life expectancy for many have been achieved by interventions that reduce early mortality through technology-based measures such as vaccination, provision of clean water, provision of health care, and improvements in nutrition. Contrariwise, a set of health issues has emerged that is less tractable to such measures. These “new morbidities” include chronic degenerative diseases as major sources of mortality for aging populations, increases in age-specific rates of chronic diseases associated with lifestyle change (such as asthma or diabetes), and the rising significance of mood and behavior disorders. The synergy between improving conditions and declining mortality as populations undergo structural and political-economic development is the concern of demographic transition theory (Omran, 1971).

The relative importance of the first class of new morbidities—chronic degenerative diseases—depends
heavily on survivorship in early life. In part, then, rising importance of such diseases is the passive product of reductions in early mortality. For instance, based on mortality rates in 1780s England, male and female life expectancy has doubled in the last two centuries (Caldwell, 2001). During this same period, mortality from chronic disease became greater than that from infection or trauma. Much more dramatic rates of increase in life expectancy have been realized in this century. From 1960 to 1990, global life expectancy rose 23% (from 53 to 65 years) and from 43 to 52 years in sub-Saharan Africa, as survivorship to age 5 years increased globally from 80.5% to 90.4% and from 74.9% to 82.5% in sub-Saharan Africa. Such rapid gains have proven to be fragile, in part because of insufficient time for enduring structural change. Thus, life expectancy in sub-Saharan Africa dropped below 50 years by 1999, largely due to the impact of HIV/AIDS (WHO, 2000, p. 29).

Over the last decade, a nearly exclusive public health focus on physical illness has given way to growing concern for mental health (WHO, 2001). The change is attributable largely to accumulating empirical evidence attesting the growing importance of mental illness (Desjarlais, Eisenberg, Good, & Kleinman, 1995), such that 5 of the 10 leading causes of disability are psychiatric and neurological conditions. Neuropsychiatric disorders contribute strongly to human suffering: they incur 28% of global disability, although they account for only 1.4% of mortality (Murray & Lopez, 1996). Conditions marked for international concern include schizophrenia, depression, Alzheimer’s disease, epilepsy, mental retardation and alcoholism (Jenkins, 2001). The shift to estimating disability adjusted life years (Murray, Lopez, & Jamison, 1994) or healthy life expectancy (Mathers, Sadana, Salomon, Murray, & Lopez, 2001) and hence to psychosocial conditions reflects increasing concern for health and well being rather than merely survival or mortality. The degree to which the increasing burden of mental health is due to absolute increases in rates or severity of disorder, or to relative decline in other sources of morbidity, remains uncertain. Depth of comparative historical data is limited by problems of ascertainment (diagnosis, recognition, or labeling of disorder), as well as the historical lack of interest in psychiatric epidemiology (Costello & Angold, 2000; Hunter & Macalpine, 1963). Against a rather shallow temporal and geographical backdrop, then, psychiatric conditions emerge as apparently significant and ascendant sources of morbidity, less so of mortality.

The disorder that accounts for the bulk of the burden of mental health is depression, a reproach to previous disregard for psychological well-being. The DALY (Disability Adjusted Life Years) approach (Murray & Lopez, 1996) has been thoroughly critiqued (Field & Gold, 1998), but it does provide the only available estimate for the burden of distress and disability on top of incidence and mortality. As of 1996, depression ranked as the fourth most important source of DALYs, contributed 10% of the global burden of disability in life years, and was projected to rank as second in importance by 2020 (Murray & Lopez, 1996), outstripping cancer, heart disease, malaria, and other established major health problems. A survey comprising comparable prevalence rates found that 1/5 to 1/3 of patients attending primary care clinics in Latin America, sub-Saharan Africa, Europe, and North America presented with depression (Almeida–Filho, 1993). Similarly, the World Bank reports depression as fifth for illness burden among women, seventh among men (Rice, Kelman, & Miller, 1992). Rates may increase with time, though data limitations constrain interpretability of secular trends. Population rates of depression in Taiwan have increased over a 30-year period even as economic circumstances and physical health have improved (Yeh, 1987), and there is arguably a trend to more depression at younger ages in the US, western Europe, Puerto Rico, Lebanon, and Taiwan (Cross–National Collaborative Group, 1992).

5. Localization

Unmasking does not sufficiently account for geographic and historical variation in relative importance of the main sources of ill health. Some morbidities confound standard prevention and treatment paradigms because they represent increasingly local or particular dynamics or conditions resistant to global solutions. Vaccination failure presents a case in point. The practice of vaccination is a cultural means for providing safe exposure to pathogens to create future immunity on the mass population level, but the success of a vaccine also depends on the immunocompetence of the vaccinee. Characteristics of the vaccine (source and nature of antigen/s) interact with those of the vaccinee (genetics, health, prior exposures) to determine the response to and efficacy of immunization. Factors such as malnutrition, heavy pathogen/parasite loads, severe stress, and early deficits in immune development can compromise immunocompetence and thus limit the effect of the vaccine (Glaser, Kiecolt–Glaser, Malarkey, & Sheridan, 1998; Shell–Duncan, 1995; Udani, 1994). The combined impact of these factors on immune function in a population or subpopulation can result in high rates of vaccine failure. When comparing vaccination failure among 80,000 infants throughout China, greater than 75% of infants seroconverted in urban areas whereas less than 70% seroconverted in rural populations (Sun, Ming, Zhu, & Lu, 2002). High rates of immunization failure occur at later ages as well. A longitudinal
population-based study of maternal child health in the Philippines found that at age 14–15 years, only 47.9% of the sample achieved an adequate positive response to a typhoid vaccine (McDade, Beck, Kuzawa, & Adair, 2001). Moreover, response was predicted by birthweight. In contrast, a study of adolescents in Durban, South Africa, identified 98% seroconversion in response to typhoid vaccination (Ramkisson & Jugnundan, 2001).

Local biology: Localization of risk is mediated by local biology and psychobiology that affect illness vulnerability or response to treatment. The concept of local biology has arisen from recognition that, while the fundamentals of human biology appear universal, details of regulation and function can differ widely (Lock & Kaufer, 2001; Lock, 1993; Worthman, 1999b). Such variation reflects the body’s reliance on and adaptive response to the circumstances under which it must function; indeed, some crucial systems, such as the nervous or immune systems, depend very heavily on inputs or exposure for the specification of their structure/function (Changeux, 1985; McDade & Worthman, 1999). Moreover, experience (particularly trauma) as well as early malnutrition have been found to affect the responses of attention and arousal regulating systems (de Bellis et al., 1994; Fernald & Grantham-McCord, 1998; Heim & Nemeroff, 2001; Lupien, King, Meaney, & McEwen, 2001; Yehuda, Teicher, Trestman, Levin, & Siever, 1996), thereby shifting the impact of the experiential vicissitudes of daily life and increasing vulnerability to stress. Cultural and physical ecology operate synergistically across the life course to generate local biologies, and thereby represent important sources of unexplained variance in health (e.g., McDade & Worthman, 1998). Contextual dynamics exert dual influences on health, first by shaping biology and hence individual function and resilience, and second by setting both the challenges faced by the individual and the external resources available to meet those challenges.

Ontogenetic pathways: This line of evidence suggests that biocultural dynamics operating through development play important roles in the production of differential health. Most simply, patterns of variation in human development can be directly linked not only to long-term outcomes in differential function and health, but also to the intervening biological adjustments that mediate those outcomes. Fetal programming exemplifies this process. Associations between neonatal outcomes (e.g., birthweight, body proportions, placental size) with risk for adult cardiovascular and metabolic disorders (Barker, 1991, 1997; Clark et al., 1996; Fall et al., 1995) have been attributed to the organizing effects of gestational conditions on basic systems such as those responsible for metabolic and state regulation (Clark et al., 1996; Fall et al., 1995; Law, Gordon, Shiel, Barker, & Hales, 1995; Seckl, Cleasby, & Nyirenda, 2000). Organizational effects set the parameters for function and future development and thereby influence risk for chronic disease. The expanding literature on fetal programming has documented the importance of early environments for health risk (McDade et al., 2001; Susser & Levin, 1999; Williams & Poulton, 1999; see also a special section of the International Journal of Epidemiology 30:15–23, 50–98) and thereby underscored the importance of maternal conditions in pregnancy for long-term well-being of offspring (Godfrey, 1998).

Early interventions that have enduring effects on function also illustrate continued sensitivity of development to environmental conditions in childhood (McEwen, 2000a,b). For instance, a 2-year nursery school education and health enrichment intervention in Mauritius resulted in improved attention regulation and orienting 6–8 years later, at age 11 years (Raine et al., 2001). Similarly, participants in preschool programs in disadvantaged areas exhibit improved social and individual functioning during the program, and later, as adults (Boivin et al., 1996; Schweinhart, Barnes, & Weikart, 1993).

Of the several directions from which anthropology has contributed to understanding the causes and consequences of differential health, developmental epidemiology has distinctively combined biological with cultural modes of inquiry to identify unrecognized relationships between behavior, development, and health embedded in the socioecological fabric of everyday life (Panter-Brick & Worthman, 1999). Such relationships comprise reciprocal interactions of culturally informed practices and the settings they create with the biologically and temporally dependent proximal processes mediating health outcomes across the lifespan. Particularly in relation to infant care, developmental ecology has shown how unpacking biocultural dynamics can reveal unsuspected pathways of biocultural coaction and causation bundled into or entwined by customary behaviors. Breastfeeding remains a quintessential exemplar of such biocultural dynamics, comprising as it does the culturally informed behavior of mother and infant to meet the latter’s immediate and intermediate nutritional needs (McDade & Worthman, 1998). Yet it concurrently addresses other crucial infant developmental needs (contact, attention, immune protection) while also suppressing maternal ovarian function to enhance birth spacing. Birth spacing, in turn, contributes to both infant survival and maternal health. Further, world-wide shifts in maturation rates, body size, and life expectancy have paralleled widespread public health interventions and socioeconomic changes that have reduced mortality (particularly early mortality), improved nutrition, and transformed lifestyles (Eveleth & Tanner, 1990; Worthman, 1999a).

The factors responsible for linking accelerated growth and development with improved adult health and life expectancy are not well understood, but a growing
literature implicates shifts in endocrine regulation. Such shifts are reflected in different levels and lifespan trajectories of the adrenal androgen DHEAS and in gonadal activity in women and men (Ellison, Panter-Brick, Lipson, & O’Rourke, 1993; Worthman, Beall, & Stallings, 1997; Worthman, 1999c). DHEAS has been linked to cardiovascular risk in women and body fat patterning in both sexes (Worthman, 2002), and appears to index lifetime allostatic load. Greater lifetime exposure to gonadal steroids as a result of early maturation and lifetime gonadal upregulation and changing reproductive schedules contributes to differential impact and side effects of birth control preparations in non-western populations (Bentley, 1994), and to increased risk for reproductive cancers in early maturing affluent populations (Eaton et al., 1994).

In sum, culturally prescribed practices of public health and child care along with social change demonstrably influence child health and survival, maturation rates and outcomes, and adult health and longevity via their impact on developmental ecology and embodied health capital (Martorell, 1995). The proximal biological mediators of these effects are not fully established. The main point is that pervasive conditions of life, or cultural ecologies, shape human development and health overtly, by means of behaviors and the larger structural and cultural conditions they reflect, and covertly, through long-term impact on biology. As such, biocultural dynamics produce local biologies with implications for function and well-being.

6. Socialization of disease

A third, related paradox, is the “socialization” of disease, whereby structural-cultural factors assume primary importance in etiology of a disorder. Because these morbidities reflect distinctive etiologies with behavioral, sociocultural roots, they require other prevention and treatment practices than the standard biomedical or public health ones. “Socialized” diseases reflect practices and social ecologies that alter exposure to health insults, as well as political or structural factors that affect exposure and vulnerability (Inhorn & Brown, 1997; McEwen, 2000b,a). The extensive body of ethnographic and epidemiological research on HIV/AIDS illustrates the significance of structural-cultural forces as barriers and assets to public health. For example, when comparing Western and African nations, sexual attitudes and behavior as well as availability of sex education curriculum place African teenagers at greater risk for HIV exposure (Essien, Ross, Ezedinachi, & Meremikwu, 1997; Courtois, Mullet, & Malvy, 2001).

Obesity prominently exemplifies socialized health risk as populations undergo a “nutrition transition” characterized by alterations in diet and activity patterns that track the changes involved in the epidemiologic transition (Popkin, 1994). Primary associated health risks are cardiovascular and metabolic diseases. While rates in some privileged countries such as the US climb steadily (US 2001 prevalence: 20.1%; Mokdad et al., 2003), those in less developed countries have surged dramatically to attain prevalences as high or higher (Popkin, Richards, & Montiero, 1996; WHO, 1998). Within-population variation by class, gender, region, and ethnicity is often marked. Historically connected with social status and overnutrition, obesity in children and adults worldwide is increasingly related to social and material deprivation to an even greater degree than is undernutrition (Peña & Bacallao, 2002). Thus, the morbidities allied to over- and underweight are becoming concentrated among the most vulnerable groups, a result of the differential impact of social change on class.

Even among British children, cumulative prevalence of undernutrition and obesity was 50% greater in most than in least deprived families (Armstrong, Dorosty, Reilly, & Emmett, 2003). In less privileged countries, the childhood stunting characteristic associated with deprivation has emerged as strongly associated with obesity; the pattern persists in adulthood (Florence, Ferreira, de Franca, Cavalcante, & Sawaya, 2001). These patterns likely are mediated by fetal programming, whereby proximal maternal stressors are translated into long-term metabolic changes in offspring: lower birthweight associated with maternal diet, stress, and materno-fetal factors has been linked to later risk for obesity and metabolic disorder related to altered setpoints in metabolic regulation (Breier, Vickers, Ikenasio, Chan, & Wong, 2001). Thus, obesity illustrates the localization as well as socialization of health risk.

The paradox of socialization includes increasing fragility of population health gains when they rest on unstable economic, political, or sociocultural grounds. The case of the Cuban embargo and B12 deficiency exemplifies this point. After the revolution, Cuba realized tremendous gains in population health, and attained excellent child health indices. However, following the collapse of the Soviet Union, Cuba’s European imports greatly diminished. Concurrently, a US embargo under the “Cuba Democracy Act” preempted importation of essential goods from other sources and led to a severe reduction in meat availability (Roman, 1994b, 1995). At that time, most women and children received micronutrient supplementation under the socialist health care system. Men, by contrast, did not receive supplements and were deprived by the meat shortage of B12 and other micronutrients. High levels of alcoholism compounded the dietary deprivation, resulting in multiple deficiencies of micronutrients including B12 (Roman, 1994a). By 1992, over 55,000 Cubans, mostly men, displayed signs of sensory neuropathy, retinopathy, and neurosensory deafness from B12.
deficiency (Borrjero et al., 1994; Sadun et al., 1994). Intervention by international health agencies circumvented the US policy and resolved most cases by providing supplementation to men in addition to the existing maternal-child programs (Roman, 1998). Roman cites two other health consequences of the US embargo: widespread cases of esophageal constriction in children who accidentally swallowed liquid lye which had been used for bathing during soap shortages, and an outbreak of inflammatory paralysis (Gullian-Barré syndrome) subsequent to an increase in Campylobacter in public water systems for which chemical treatments were no longer available. The Cuba Democracy Act and its health sequela illustrate how political and economic events open pathways of illness typically unforeseen by standard epidemiological models. Amelioration of “socialized” challenges to health will require social or cultural “prescriptions” rather than pharmacologic or sanitary ones.

7. Re/emerging diseases

Emerging infections are defined as “new, reemerging, or drug-resistant infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future” (Lederberg & Shope, 1992). All of the six major factors driving emerging and reemerging infections—changes in human demographics and behavior, changing industrial and land use practices, accelerated travel and commerce, breakdown of public health capacity, and microbial evolution—arguably involve human behavior and are linked to socioeconomic transformations known as “development.” Hence, re/emerging infections manifest paradoxes of progress that affect health (WHO, 1996). They also involve both sides of infection: exposure and vulnerability. Malnutrition, chronic deprivation, neglect, and ongoing health and other physical and mental stresses contribute to vulnerability. Overcrowding, population displacement or migration, poor sanitation and living conditions, diet change and food production, disruption of health care, and the viral “superhighway” paved by escalating international trade and travel, all contribute to exposure (Armelagos, 1998).

Emerging diseases: The public health goal of disease eradication has rarely been achieved when assessed in light of the increasing rates of emerging novel diseases. Over 30 of these diseases have been identified in the last 25 years, including HIV/AIDS, Ebola virus, hantavirus, and new strains of hepatitis, cholera, and E. coli (WHO, 1996). A substantial literature deals with new disease outbreaks of old infectious diseases as a threat to health (Barrett, Kuzawa, McDade, & Armelagos, 1998). Human behavior and ecology influence not only infection, but also rates of evolution and virulence of pathogens. For instance, both distribution of and differences in virulence among strains of HIV are influenced by sexual practices and transmission rates (Ewald, 1996). Virulent strains of HIV-1 have spread rapidly in Thailand where rates of expected transmission are high. By contrast, the less virulent HIV-2 has been associated with populations having lower transmission rates (Ewald, 1991, 1999). These patterns predict that in Japan, where HIV-1 has recently been introduced, virulence will decline if transmission rates remain low. Such models also suggest a vicious cycle of the preventable social factors that promote rapid transmission (e.g., extreme poverty, dislocation), with the differential expansion of virulent strains.

Ecological, demographic, and health policy dynamics behind emergence are illustrated by an outbreak of monkeypox in the Democratic Republic of Congo. Smallpox-vaccinated individuals are resistant to the monkeypox virus, which is closely related to smallpox but is carried in wild reservoirs. Cessation of smallpox vaccination after 1983 resulted in an increase in susceptible people, among whom increasing population pressure and increased consumption of wild animal foods also led to increased transmission from animals (Hutin et al., 2001).

Re-emerging diseases: The paradox of reemergence has disconcerted the public health world by producing risk in the face of success. Re-emergence comprises the appearance of more virulent forms of previously tractable infectious diseases or increased incidence of previously infrequent or declining diseases. This paradox comprises two features. For one, the means of achieving prior successes have fueled re-emergence of those same health problems via pathways forged by both the nature of pathogens, and the nature of humans and their behavior. For another, expanding pools of vulnerable individuals create crucibles for development of such strains.

The resurgence of tuberculosis and the emergence of antibiotic-resistant strains illustrates this point. In 1999, tuberculosis killed nearly 1.7 million people worldwide, accounting for 3% of all mortality. Among infectious diseases, mortality from tuberculosis ranked ahead of malaria and measles and was exceeded only by respiratory infections, HIV/AIDS, perinatal conditions, and diarrheal diseases (WHO, 2000, p. 164). Poverty, social marginalization, crowding, and homelessness increase the risk of infection. In the US, after declining by nearly 6% per year from 1953 to 1985, the number of cases increased by 20% and transmission rates rose during 1985–1992 (Cantwell, Snider, Cauthen, & Onorato, 1994). The increase in cases was seen disproportionately in young adults ages 25–44 years (80% of the increase), ethnicities other than non-Hispanic whites (96%), the foreign born (60%), the poor (average annual incidence 33 vs. 4 per 100,000 in affluent...
households), and persons with HIV. Such factors contributed to the dire situation in New York City where by 1992, cases of tuberculosis had tripled and the case rate (222 per 100,000) outran that of many developing countries (Frieden, Fujiwara, Washko, & Hamburg, 1995). Inappropriate or inadequate treatment, hunger, population displacement, and HIV all increase transmission rates and contribute to the 1.8 billion TB-infected people worldwide (Espinal, et al., 2001; WHO, 1999). Although resurgence in the US followed a long period of decline, many other countries never experienced that decline and tuberculosis remains a leading infectious cause of death among young adults (Farmer, 1999). Fluctuation in incidence of malaria, a similarly persistent disease, is also highly sensitive to human and natural ecology. Thus, it is a sensitive indicator of those ecologies. For instance, political conflict now threatens accomplishments by widespread malaria eradication programs. By illustration, the influx of Afghan refugees to Pakistan has led to an outbreak of malaria in an area of the country with previously low rates of transmission (Kazmi & Pandit, 2001).

The literature on emerging diseases has focused on infectious forms, but rapid, sociobehaviorally mediated increases in non-communicable diseases among previously low prevalence groups might also be considered as re-emerging diseases. Impact of lifestyle change on age-specific rates are similarly well documented for non-communicable chronic conditions as for infectious ones. Take diabetes—an emerging pandemic. Dramatic world-wide increases in rates of secondary diabetes have been linked to changes in quantity and composition of dietary intakes, sedentization and concomitant reduction in energy expenditures and physical fitness, and new forms of labor and social relations that alter cognitive-emotional impacts on metabolism. A recent report (International Diabetes Federation (IDF), 2001) identifies diabetes as one of the most common non-communicable diseases, one which afflicts over 150 million persons. Non-insulin-dependent diabetes mellitus accounts for 85–96% of these cases. India, China and the United States have the highest number of sufferers, and Mexico (14.2%), Hong Kong (12.1%), and Pakistan (11.8%) are among the top 10 countries measured by prevalence. Diabetes most severely affects the western Pacific region, and Papua New Guinea (15.5%) ranks first in the world in prevalence. The IDF cites cultural and socioeconomic transitions, urbanization, new dietary practices, and more sedentary lifestyles as major contributors to the worldwide epidemic of diabetes. Similarly large global increases in obesity result from comparable conditions (WHO, 1998).

Asthma is another chronic disorder that might be considered a re/emerging disease. In the last 25 years, global incidence and prevalence of morbidity and mortality from asthma have increased. Prevalence of childhood asthma increased annually from 1956 to 1989 by between 1.3% and 12.4% in a sample of countries (England, New Zealand, Sweden, Switzerland, France, Finland, and Taiwan) (Hurtado, de Hurtado, Sapien, & Hill, 1999). Diet, hygiene, and patterns and levels of allergen exposure have been consistently implicated in the etiology of the asthma (Barnes, Armelagos, & Morreale, 1999; Matricardi, 2001). Similarly, studies in the US cite residence quality, particularly with respect to high burden of allergens and cockroach populations, as a key factor (Eggleston, 2001). Asthma disproportionately affects economically marginalized groups (Ellison–Loschmann & Pearce, 2000; Hurtado et al., 1999). Stress may also contribute to increases among specific populations by affecting immune regulation (Marshall & Agarwal, 2000). Public health policies recommend major changes in human ecology, including inner city eradication of cockroaches as well as a reduction of allergens by 80–90%, to see a significant reduction in asthma incidence (Wood, Eggleston, Rand, Nixon, & Kanchanaraksa, 2001). Environmental pollution also plays a role. For instance, worsening air quality has been shown to contribute to increasing rates of asthma in China, where asthma is a formidable health concern (Chan-Yeung, 2000; Zhang, 2000).

Overall, emerging non-communicable conditions represent threats to health that nearly match those from some emerging infectious diseases.

8. Savage inequity

The previous four paradoxes gain greater force through a final one, namely, the persistence of poverty, inequality, and inequity despite unprecedented escalation in total human resource consumption and material culture. Although all signify availability of resources, each denotes distinctive conditions with potentially dissimilar health consequences. Poverty is the absolute lack of material resources. Inequality is the unequal distribution of resources and their correlates, such as inequalities in health care (Black, Morris, Smith, & Townsend 1982). Inequity is perceived unfairness in the distribution of resources. Inequity has escalated to savage heights through extreme resource extraction rates coupled with increasing, widely visible disparities in access to resources. Consequently, global availability of resources is perceived as high, and the benefits of those resources (lifestyle, consumables, happiness, health) are globally visible through media. Such perceptions (and realities) sharpen dissonance and frustration when local opportunities for access are low and conditions of life poor or deteriorating (Pedersen, 2002). In the following discussion, the term we use to gloss all three is inequity, but we use each in its specific sense wherever possible.
It has been difficult to discern whether it is the lack of resources themselves, their unequal distribution, or the perception of unfairness that mediates the impact of disparity on health. Available evidence speaks mainly to the first two (Adler, Marmot, McEwen, & Stewart, 1999); after an initial focus on poverty itself (but see Heuveline, Guillot, & Gwatkin, 2002; Peña & Bacallao, 2002), inequality has been the prime focus for over two decades (Macintyre, 1997). Most studies do not assess perceived inequity and thus confute its possible effects with those of inequality. Cross-national comparisons reveal that economic inequality is negatively correlated with life expectancy and other indices of mental and physical health (Kaplan, Pamuk, Lynch, Cohen, & Balfour, 1996; Kennedy, Kawachi, & Prothrow–Stith, 1996; Wagstaff & van Doorslander, 2000; Weich, Lewis, & Jenkins, 2001; Wilkinson, 1996). Income itself is strongly and directly related to mortality (Adler, et al., 1999; Haan, Kaplan, & Syme, 1989): for instance in the US, poor persons have over twice the risk of death than do persons with high income (Lochner, Pamuk, Makuc, Kennedy, & Kawachi, 2001). Some have objected that the strong income–health relationship produces an artifactual significance for income inequality when aggregate data are used (Gravelle, 1998), but longitudinal data show that mortality risk operates at the individual level while income inequality operates at the ecologic level (Lochner et al., 2001).

Therefore, something about resource disparity, or the conditions that create it, impairs health (Brown, 1987). Causal pathways have been intensely debated (reviewed in Macintyre, 1997). For instance, a recent analysis evaluated three potential reasons that income and socioeconomic status (SES) are related to health: (1) causality, or effect of SES on exposure to risk factors for poor health; (2) selection, or the impact of individual health on social status; and (3) artifact, or the effects of methodological problems (e.g., measurement error) or cryptic confounds (Goldman, 2001). The first pathway was found to be best supported by the evidence (see also, Quinn, 2001), but also suggested that person-centered approaches (Singer, Ryff, & Curr, 1998) rather than variable-based methodologies will be needed to elucidate how the pathway works. High variance in health outcomes at the bottom of the SES–health curve compared to the top of the curve suggests hierarchies of life history and associated health risks (Singer & Ryff, 1999). Mounting evidence for such hierarchies includes the previously discussed effects of early life experience, for early experience appears to set how vulnerability is accumulated throughout the life course.

Mediators from inequity to health Davey Smith (1996) has suggested that inequality curtails social investment, undercuts development of embodied capital, and thereby contributes to poor health outcomes in the future. Embodied capital comprises the enduring social and physical assets of individuals. Social investments including education, welfare, and infrastructural improvement confer long-term benefits in lasting psychosocial and physical gains that promote well-being (Caldwell & McDonald, 1982). Educational advantage leads to persistent and widening advantage in mortality (Mulher, 2002). Increased disparity erodes the health gains achieved through earlier improvements in sanitation, prophylaxis, and treatment by undermining embodied capital.

For the underprivileged, inequality furthermore leads to progressive disadvantage and exacts a cumulative toll on health across the life course, so that the societal gap in health widens with age (Adler, 2002; Caldwell, 2001; Wolfson, Rowe, Gentleman, & Tomiak, 1993). Cumulative disadvantage accrues through the additive and even multiplicative effects of factors such as persistent hardship on various dimensions of well-being—physical, emotional, cognitive, and social (Gwatkin, 2000; Lynch, Kaplan, & Shema, 1997; Seeman, McEwen, Rowe, & Singer, 2001). Early advantages or insults during gestation or childhood have long-term, time-lagged effects on health (Barker, 1991; Davey Smith, 1998). Prenatal undernutrition, for instance, has been associated with increased risk of impaired immune response in adolescence as well as cardiovascular and metabolic disorders in adulthood (Barker, 1998; Leon & Walt, 2001; McDade et al., 2001).

Wilkinson (1997, 1999) has argued that the psychosocial impact of relative SES (inequity) plays a central role in its effects on health. Such psychosocial factors include insecurity, isolation, anxiety, and depression from perceived lack of control; degree of social peripheralization, subordination, and social support (including negative or demanding relationships); perceived opportunity; expectations for survival and quality of life; conditions of work and of residence; and likelihood of adverse life events (Kaplan et al., 1996; Marmot & Wilkinson, 2001). The role of psychosocial factors may account for the persistent observation that the relationship of SES to health pertains even across rather fine status differences in the middle class (Marmot et al., 1991; Stansfeld, Bosma, Hemingway, & Marmot, 1998). Even among the employed civil servants in the Whitehall Study, differences in physical and mental health were significant and linear by grade independent of prior illness and health related behaviors. Work characteristics and social relationships appear to mediate these relationships, although the confound of phenotypic correlation (antecedent characteristics predict work and relationships) is difficult to exclude (Brunner & Marmot, 1999; Stansfeld et al., 1998). A number of studies in the US have corroborated these findings, including a report that even in healthy women of relatively strong social standing, physical health indicators and psychosocial functioning were more
strongly and persistently associated with subjective rather than objective SES (Adler, Epel, & Ickovics, 2000).

**Impact on vulnerability:** Exacerbated differentials in resource use along with globalization, demographic change, and sociocultural transformations have dramatically expanded the pool of marginalized, highly vulnerable and chronically exposed humans (Desjarlais et al., 1995). All but 6 of the 48 countries comprising the bottom 25% of healthy life expectancy worldwide are in sub-Saharan Africa (Mathers et al., 2001), where the greatest poverty, largest continental concentration of military conflict (Murray, King, Lopez, Tomijima, & Krug, 2002), and highest rates of HIV/AIDS (Ataka, 2001; Quinn, 2001) operate in deadly synergy. Post-communist countries also demonstrate the direct effects of political–economic change. Against a backdrop of prior relative equity and resource stability, increased material deprivation and reduced perceived control have been found to be strongly and negatively related to self-rated health in these countries (Bobak, Pikhart, Rose, Hertzman, & Marmot, 2000) and depressive affect (Kopp, Skrabski, & Szedmak, 2000; Kopp, Szedmak, & Skrabski, 1998; see also Bobak & Marmot, 1996). The impact of reduced embodied capital and the impaired function incurred by misery, conflict, social disruption, and social disinvestment exacts a large toll on everyday well-being above and beyond effects on mortality. That is to say, disability exerts greater absolute and relative effect on healthy life expectancy (that is, discounted by illness/disability) in poor than in affluent countries. Healthy life expectancy therefore increases more rapidly than total life expectancy as average per capita health expenditures increase (Mathers et al., 2001).

Impoverishment, created by the persistence and escalation of inequities, fosters transformation of older pathologies to unprecedented virulence. The case of re-emerging TB and emerging MDR-TB strains in the US discussed above exemplifies this point. From 1983 to 1989, the top 1% of income earners in the US accrued 66% of the gain in net wealth, the next 19% realized 37%, and the remaining—the majority—80%, lost 3% (Kaplan et al., 1996). Partial access to care, eroded social integration, poor nutrition, impaired psychological functioning, and adverse health behaviors associated with reduced social investments and declining material conditions for many coincided with and directly contributed to the re-emergence of TB and emergence of resistant strains (Espinal et al., 2001; Farmer, 1999).

**Absolute vs. relative SES:** Rising interest in the impact of SES inequity on health inequity (Gakidou, Murray, & Frenk, 2000; Gwatkin, 2000) has prompted some analysts to underscore the importance of deprivation per se, and to stress the need to address the incomes of the poor (Deaton, 2001; Lynch, Due, Muntaner, & Davey Smith, 2000). For individuals, income emerges as a primary factor in their health, but it appears less significant on the aggregate level (Marmot & Wilkinson, 2001). The two dimensions of income—absolute and relative—clearly have an effect on health, but their relative importance may change with aggregate levels of affluence and social capital (Der, 2002).

### 9. Paradoxes of success and the social production of health

We noted at the outset the high level of unexplained variance in health outcomes, and suggested that the paradoxes of success are grounded not only in their manifest linkages to health risk, but also in their relationships to conditions responsible for the production of health. We further suggested that the factors responsible for buffering health risk (resilience) are not necessarily the converse of those that produce it. Rather than reviewing the growing literature on resilience (Garmezy, 1991; Garmezy, Masten, & Tellegen, 1984; Haase, Heiney, Ruccione, & Stutz, 1999; Luthar, Cicchetti, & Becker, 2000; Masten, 2001; Roosa, 2000; Rutter, 1990; von Eke & Schuster, 2000), we consider what current paradoxes—and the synergies among them—demonstrate about the conditions that promote health and the capacity for health maintenance in the face of challenge.

The paradox of unmasking arises because as the sources and schedules of mortality have shifted, so has the relative importance of infectious and chronic disease. Consequently, the relative impact of factors contributing to burdens of impairment, morbidity, and mortality has also been adjusted (Caldwell et al., 1990). Those factors relevant to chronic illnesses have assumed greater significance in determining health outcomes than those relevant to infectious diseases. Because chronic illness has a later onset and longer course, the focus on contributory antecedent processes widened to include behavioral, structural, as well as biological ones. For instance, with respect to obesity and diabetes, the discovery of fetal programming led to recognition of the significance of maternal condition (nutrition, stress, illness) for fetal nutrition in genesis of these conditions in the next generation. Fetal programming furthermore has been found to interact with later exposure, such that diet (calorie-, simple carbohydrate-, and lipid-dense) differentially affects those of low or high birthweight (Harding, 2001). Thus, dietary changes interact with the conditions that influence maternal health to undercut a previous synergy between poor maternal conditions as predictors of nutritional conditions their children will experience. That synergy made metabolic programming an adaptive source of resilience under adversity. Whereas previously obesity was an affliction of high status, it is now increasingly a marker of deprivation as this adaptive mechanism becomes a health risk.
Localization generates paradox when interventions applied globally (immunization, pharmacology) exert local effects that alter their efficacy and consequently exacerbate health disparities. The paradox of localization un masks the diversity of local biologies along with biocultural interactions that determine the course of development and the generation of embodied capital (e.g., immunocompetence, metabolic regulation, cognitive capacities). Ontogeny incorporates proximate information about environmental demand, allowing the environment to “instruct” the individual in the requisites for local competence, both cognitive and physical. We take asthma as an example that also illustrates a synergy between unmasking and localization. The impact of infectious causes of early mortality throughout human history placed a high premium on rapid acquisition of exposure-informed immunocompetence. But radical changes in the pattern of early antigen exposures (including vaccination) have triggered immunodevelopmental changes manifested in asthma. Apparently, what was previously a highly adaptive synergy between immune development and environmental exposures has acquired pathogenic sequelae as early exposure patterns have shifted. So embedded is this synergy that the spread of asthma remains unexplained. We note in passing that local biology has implications not only for variation in the forms of appropriate treatment, but also for variation in the forms and courses of “global” diseases. HIV/AIDS illustrates this phenomenon particularly vividly, for the interaction of evolving virus/es with social conditions (poverty or marginality, malnutrition and poor health, access to care, inequality) has lead to differential forms, courses, and sequelae of infection within and among populations (Gaylin & Kates, 2002).

In this vein, synergy between the paradox of socialization with that of re/emerging diseases reveals underlying dynamics in the production of health. The unfolding HIV/AIDS pandemic manifests these dynamics in devastating detail, particularly in sub-Saharan Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged, the extent of viral genetic variation is greatest, and 70% of cases reside in Africa where the virus emerged. Fifteen years ago, a 7% seroprevalence in Kinshasa appeared dramatic but until recently has remained stable through severe civil disruption and conflict, whereas a very low prevalence in Botswana 15 years ago has climbed to 40% in this relatively affluent and stable country (Weiss, 2003). The primary mode of transmission, sexual contact, is fueled by many social and cultural factors, including labor migration, poverty and social isolation of the young, and traditional practices such as breastfeeding or circumcision (Dabis & Ekpini, 2002; Weiss, Quigley, & Hayes, 2000). Other
which these dynamics operated. Maternal health, conditions of child care and feeding, household composition and dynamics, patterns of exchange and reciprocity, access to social and material resources, housing and neighborhood, labor patterns, and even social constructions of life history all were affected by these changes. Ballooning population size, juvenilization of age structure, structural debt and economic instability, environmental degradation and asset depletion, and political fragility not only structure daily lives and prospects, but also fuel political and armed conflicts along with social fragmentation (Pedersen, 2002). This is clearly seen with the exponential increases in numbers of displaced peoples since the 1970s (Desjarlais, et al., 1995). Thus, structural factors threaten to overwhelm local processes that produce health in the course of everyday life and render them vulnerable to uncertainty, instability, and depletion.

On a much less global and more concrete level, many Aboriginal groups have exemplified the failure of medical technology to facilitate health in the face of historical savage inequity. Studies with Aboriginal groups in Canada and Australia have explored the application of interventions that harness interacting forces of health production. Results suggest that until a community’s sense of coherence and control is addressed, other public health and medical interventions will not have optimal success (Daniel, et al., 1999; Rowley et al., 2000). These interventions themselves ameliorate savage inequity by incorporating the Aboriginal populations in development and execution of the public health work, thus—hopefully—addressing negative forces of socialization and local biological predispositions to diabetes.

10. Conclusions

Modern visions of the horizons of health have receded as emerging challenges confound theory and practice in public health and biomedicine. These challenges apparently arise from the very means used to achieve success. Analysis of the paradoxical sources of failure-in-success identifies sources of limitation in our present approaches. First, the paradoxes result in part from theories and interventions that struggle to isolate specific pathways for health improvement when health actually occurs at a nexus of convergent factors at diverse levels—individual, household, community, population, and world system. As such, these factors cannot be dissociated without altering their actions and reconfiguring the determinants of health. Integrative models directed at this nexus may paradoxically be more generalizable by being more contextualized and contingent. Second, in each case, biocultural dynamics previously responsible for adaptive health maintenance can become sources of health risk, unwittingly released when those dynamics are altered.

The sense of impending failure despite apparent success of public health and medicine in promoting health, along with closure of the epidemiologic circle such that none is immune to emerging health risks, create opportunities to press further for structural and economic change and reformulation of health theory and praxis. The present analysis contributes to an increasingly urgent discourse advising that such top-down changes are critical. Further revision and integration of theories concerning socioeconomic development and the epidemiologic, demographic, and nutritional transitions are needed to inform this effort. Additionally, recognition of the important roles socio-behavioral factors play in increasingly significant risks to health has stimulated interest in specifying the pathways by which these factors produce differential well-being and influence health risk, in order to identify novel health-promoting interventions or realize improved implementation of existing health measures. As illustrated throughout our discussion, substantial evidence from the biomedical, epidemiologic, and public health literatures are available to assist in the process of tracing biocultural pathways.

Our analysis also highlights bottom-up production of health. The bedrock of health is largely transparent, embedded in the conditions and actions of everyday life, and is dynamically produced by these ongoing conditions and actions. As the paradoxes demonstrate, changes in life conditions and behaviors alter the constituent dynamics with consequent changes in patterns of health, for good and ill. Structural factors establish the base conditions or distribution of conditions under which the constituent dynamics must operate. As such, they create conditions permissive or conducive to health production thereby exert major effects on health. The horizons of health can be advanced, principally by enlisting and empowering rather than antagonizing the powerful biocultural dynamics surveyed here, and by assisting societies to get on with the everyday production of health by implementing both bottom-up and top-down approaches.

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