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Intelligence: Is It the Epidemiologists' Elusive "Fundamental Cause" of Social Class Inequalities in Health?

Linda S. Gottfredson
University of Delaware

Virtually all indicators of physical health and mental competence favor persons of higher socioeconomic status (SES). Conventional theories in the social sciences assume that the material disadvantages of lower SES are primarily responsible for these inequalities, either directly or by inducing psychosocial harm. These theories cannot explain, however, why the relation between SES and health outcomes (knowledge, behavior, morbidity, and mortality) is not only remarkably general across time, place, disease, and kind of health system but also so finely graded up the entire SES continuum. Epidemiologists have therefore posited, but not yet identified, a more general "fundamental cause" of health inequalities. This article concatenates various bodies of evidence to demonstrate that differences in general intelligence (*g*) may be that fundamental cause.

When Charles Spearman (1904, 1927) discovered the general intelligence factor, *g*, a century ago, he simultaneously revealed perhaps the most important fact about it: Namely, *g* is a highly *general* ability. The mental tests he subjected to factor analysis contained quite different kinds of manifest content (e.g., understanding paragraphs, doing arithmetic, following instructions, estimating lengths, remembering words, identifying absurdities in pictures), yet performance on all of them was influenced by the same common factor. That is, people who scored high on the general factor, *g*, tended to score well on all the individual tests, and people who scored low on the common factor tended to perform poorly on all tests. Such results have been replicated countless times since (Carroll, 1993).

Psychometric and biological evidence (Carroll, 1993; Jensen, 1998) has now persuaded most researchers that the *g* factor really exists (i.e., is not just a statistical artifact), but questions remain over how truly general it is (Sternberg & Grigorenko, 2002). Skeptics often argue that *g* is only an academic ability and that there are other, coequal intelligences that not only are independent of *g* but also are more important outside of school settings (e.g., Gardner, 1983; Sternberg et al., 2000). These multiple-intelligences hypotheses have not been borne out when actually tested (Brody, 2003; Gottfredson, 2003; Hunt, 2001; Koke & Vernon, in press), and much research has shown that *g* actually plays a rather substantial role in practical affairs, especially in performing jobs well (J. P. Campbell, 1990) and getting ahead socioeconomically (Jencks et al., 1979; Murray, 1998).

Far less research has examined *g*'s impact on physical health, but the past century of research on *g* can be brought to bear on the issue. Many thousands of studies have examined *g*'s psychometric properties, distribution across individuals and groups, genetic and environmental roots, physiological correlates in the brain, influence on individuals' behavior and life chances, and impact on a society's social, political, and economic life (e.g., Brody, 1992; Carroll, 1993, 1997; Deary, 2000b; Gordon, 1997; Herrnstein & Murray, 1994; Jensen, 1998; Schmidt & Hunter, 1998; Sternberg & Grigorenko, 1997; Vernon, 1993). This vast and dense network of generalizations can be used to make predictions in areas of human activity not yet assayed for the involvement of *g*. I refer to this network and related predictions as *g* theory. The analytic strategy I pursue here is to ask whether (a) the data on daily self-maintenance, health self-care, and prevention of accidental injury conform to the predictions of *g* theory and whether (b) *g* theory can explain social class differences in health better than can conventional theories of social inequality.

Conventional theories of social inequality posit that social class disparities in health result from disparities in material resources, such as access to medical care. Health demographers have become increasingly puzzled, however, by certain glaring failures of the poverty paradigm. The chief puzzle is why the relation between social class and health is so remarkably general across diverse times, places, and diseases and despite improvements in health care. In fact, greater equalization of health care and falling rates of morbidity and mortality tend to widen social class differences in health (Steenland, Henley, & Thun, 2002). Such paradoxes have led health demographers to posit some highly general and enduring—but still mysterious—fundamental cause of health inequalities that transcends the particulars of time, place, disease, material advantage, and social change (Adler et al., 1994).

I argue that *g* may be that fundamental cause because it meets six criteria that any candidate for the cause must meet: It has a stable distribution over time, is replicable (passed from one generation to the next), is a transportable form of influence, has a general (pervasive) effect on health, is measurable, and is falsifiable. A review of pertinent elements of the nomological network for *g* shows that *g* already meets all but the fourth criterion, so I focus on the fourth by examining *g*'s breadth of effect on health knowledge, behavior, and outcomes. First, generalizable effects for *g* have been found in education and work, and the same factors that put a big premium on *g* in those realms, especially task complexity, also increase risk of poor health self-care. Second,

Correspondence concerning this article should be addressed to Linda S. Gottfredson, School of Education, University of Delaware, Willard Hall, Newark, DE 19716-2922. E-mail: gottfred@udel.edu

successively better surrogates for *g*—income, occupation, education, health literacy—are successively stronger correlates of health outcomes. Analyses of the "job" of being a patient show that it requires the same cognitive skills that *g* represents and that most jobs require for good performance: efficient learning, reasoning, and problem solving. Both chronic diseases and accidents incubate, erupt, and do damage largely because of cognitive error, because both require many efforts to prevent what does not yet exist (disease or injury) and to limit damage not yet incurred (disability and death) if one is already ill or injured.

Many factors no doubt contribute to the eruption and progression of particular diseases and accidents. Neither the poverty paradigm nor *g* theory would argue that its fundamental cause is the sole or even major determinant of why particular individuals experience particular diseases or accidents. Although explaining individual differences in specific outcomes is important, the primary aim here is to explain something else, namely, the remarkably general differences between social groups in their rates of disease and injury. The latter are more affected by the cumulation of consistent effects across persons and time within groups. When groups differ substantially on the average in IQ but not other factors causing individuals to become ill or injured (e.g., non-*g*-related genetic risk or motivation), then even small *g*-related differences in risk at the individual level can cumulate over persons to produce large group differences in rates of morbidity and mortality. This means that although risk factors that create group differences in health also create individual differences in health, the reverse is not necessarily true. That is, it explains how a single fundamental cause might account for most between-groups, but not most within-group, differences in health.

The Generality of *g* and Its Relation to Social Class

Fuller discussion of the following key points about *g* and its relation to personal well-being can be found in any good textbook on the nature, measurement, and correlates of general intelligence (e.g., Brody, 1992; Deary, 2000b; Jensen, 1998; Plomin, DeFries, McClearn, & McGuffin, 2001) as well as in short pieces for more general audiences (Deary, 2000a; Gottfredson, 1996, 1998, 2000).

g Is a Highly General Ability to Learn, Reason, and Solve Problems

The first key fact is that *g* is a content- and context-free ability to process information of any sort. The *g* factor dominates tests of very different manifest content and thus constitutes the backbone of all human mental abilities. Factor analyses of broad test batteries administered to different races, sexes, ages, and national groups have yielded essentially identical *g* factors (Jensen, 1998, pp. 85–88), so the *g* factor dimension of human difference appears to be a product of nature, not culture. The high generality of *g* is also seen in the more specific skills and abilities that typify high-*g* persons: reasoning, conceptual thinking, problem solving, and quick and efficient learning. All are general-purpose abilities, applicable to any task or life setting. *g* fits many lay and expert definitions of the term *intelligence*, and many intelligence experts have, in fact, adopted *g* as their working definition of intelligence. A group of 52 experts described its everyday manifestations in this way:

> Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—"catching on," "making sense" of things, or "figuring out" what to do. (Gottfredson, 1997a, p. 13)

In short, *g* is an especially general tool in the larger tool kit of human abilities, because it is not bound to particular content or circumstances but allows people to deal with complexity in all of them. It is hardly the only useful tool, and it can be used wisely or foolishly, for good or evil. Nonetheless, it has pervasive utility.

g's Practical Value Is Pervasive and Increases When Tasks Are More Complex

The nonacademic value of *g* has been well documented by personnel selection psychologists. Nearly a century of research (Schmidt & Hunter, 1998, 2004; see also Gottfredson, 2002) shows that *g* predicts on-the-job performance to some extent in all jobs (a corrected correlation of .50, on the average), best in the most cognitively complex jobs (from about .20 in the simplest jobs to .80 in the most complex), best when performance is measured objectively and relates to the most core technical duties of a job, and almost always better than any other type of predictor. Specially tailored batteries of cognitive tests do little better than a lone measure of *g*. With only one exception—conscientiousness/integrity—none of the less cognitive traits yet measured (temperament, interests, and the like) adds much if anything to the prediction of core job performance, except sometimes in narrow groups of jobs. Noncognitive traits equal or surpass *g* only when predicting certain more peripheral aspects of job performance, such as organizational citizenship (helpful to coworkers, professional demeanor, etc.). Psychomotor abilities (eye–hand coordination, manual dexterity, etc.) and length of experience in a job predict performance best where *g* predicts it least, namely, in the lowest level, most routine jobs.

g affects job performance primarily indirectly, by promoting faster and more effective learning of essential job knowledge, during both training and experience on the job. Higher levels of *g* also enhance job performance directly when jobs require workers to solve novel problems, plan, make decisions, and the like. *g* appears to have increasingly large direct effects when jobs are less routinized or less closely supervised; more fraught with change, ambiguity, unpredictability, and novelty (and hence are inherently less trainable); or otherwise require greater exercise of independent judgment and innovative adaptation (Schmidt & Hunter, 2004).

The foregoing results for the predictive importance of *g* in the workplace dovetail with analyses of the tasks that different jobs require workers to perform. Factor analyses of jobs' task requirements show that the biggest difference among them lies in the complexity of information processing they require. Two large studies show clearly that the dominant first factor among jobs' functional demands amounts to a requirement for *g*. For instance, Arvey's (1986) large Judgment and Reasoning factor correlated most highly with rated demands for both greater aptness at learning a job (e.g., "learn new procedures quickly," "learn and recall job-related information") and spotting and solving unexpected problems once on the job (e.g., "identify problem situations quickly," "deal with unexpected situations"; Arvey, 1986, Table 1, p. 418). Gottfredson's (1997b) large first factor, Overall Job Complexity, correlated most highly with occupational prestige and the need for workers to compile, combine, communicate, and analyze written, spoken, and visual information, whether verbal, quantitative, or behavioral, and to do so under conditions entailing much responsibility, little supervision, and considerable psychological stress. In contrast, the simplest, lowest prestige jobs, in which *g* does little to predict performance, tend to be highly routinized, repetitive, and supervised and to call mostly for physical strength and tolerance of unpleasant physical conditions (Gottfredson, 1997b, pp. 100–105).

In short, the advantages conferred by higher levels of *g* are successively larger in successively more complex jobs, tasks, and settings. Greater experience and other favorable personal traits can compensate to some extent for lower levels of *g*, but they can never negate the disadvantages of information processing that is slow or error prone. In essence, brighter workers always have a stronger tail wind at their backs. To the extent that everyday tasks mirror tasks performed for pay, such tailwinds are felt in many spheres of life.

g Is a Highly Heritable Ability and Not Permanently Influenced by Family Advantage

Another crucial fact is that *g* is highly heritable and not permanently affected by the rearing circumstances that siblings share (Bouchard, 1998; Plomin et al., 2001). (Heritability is the proportion of observed variation in a characteristic that is due to genetic variation in the particular population studied.) The heritability of general intelligence ranges from 20% in infancy to 40% in early childhood, 60% in adolescence, and 80% in mid to late adulthood. Not only do environmental effects tend to dissipate with age, but one class of them disappears almost completely—the effects of shared family circumstances (e.g., parents' education, income, and childrearing practices). (These data pertain primarily to the middle 80% of family environments in developed nations and therefore do not reflect the possible effects of extremely deprived or privileged upbringing.) Whereas up to 25% of IQ differences at ages 4–6 can be traced to shared family characteristics (with another 35% to nonshared environments and measurement error), both longitudinal and cross-sectional studies have estimated that shared family environments account for virtually no IQ differences by late adolescence. The only environments that create lasting differences in *g* are thus those that siblings do not share and that affect individuals only one person at a time. (We still know little, however, about what the specific nonshared factors might be; Rodgers, Rowe, & May, 1994.) These behavior genetic results do not mean that environments are unimportant but only that one large class of environmental factors—shared family background—cannot explain the large, lasting individual differences in intelligence in a population. From adolescence on, siblings are similar in IQ only for genetic reasons. Class-based theories of social inequality are mistaken when they assume otherwise.

On the other hand, siblings differ for both genetic and (nonshared) environmental reasons. The laws of genetic transmission guarantee that biological siblings will share only 50% of their segregating genes with each other, on average, and that they will share exactly 50% of their genes with each parent. Thus, even when traits are 100% heritable, the correlations between siblings and between parents and their children are at most only around .50. (Assortative mating, which exists for IQ, would cause these correlations to increase somewhat; Jensen, 1978). Even in childhood, siblings differ by an average of about 12 IQ points, which is two thirds the average difference between strangers (17 points; Jensen, 1980, p. 43; Plomin & DeFries, 1980).

g Is at the Center of the Causal Nexus for Socioeconomic Success and Pathology in Adulthood

Education, occupation, and income are moderately intercorrelated and therefore form a nexus of success. Chronic unemployment, poverty, single parenthood, and criminality likewise form a nexus of social pathology. All these adult outcomes correlate with family background, the successes positively and the pathologies negatively. Social scientists usually argue that differences in family advantage are the chief cause of these inequalities among the adult offspring. They likewise tend to think of high IQ as just one more consequence of advantaged rearing environments and therefore as one of various mechanisms by which social advantage is transmitted from parent to child.

Four facts call this class-based theory of social inequality into question and implicate *g* as the more fundamental causal force in the intergenerational transmission of social inequality (see also Scarr, 1997, on socialization theory). The first fact is that adolescent IQ cannot serve as a conduit for socioeconomic advantage across generations because, as noted earlier, it is not affected by shared family advantages (parental education, income, childrearing style, etc.). IQ cannot transmit what leaves no imprint on it. To the extent that IQ is transmitted intergenerationally, it is only through the genes. (The same is true for personality traits; Loehlin, 1992.)

The second fact is that children's IQ predicts their later socioeconomic success better than do their parents' attributes. For instance, sons' education, occupation, and income correlate higher with their own IQ (true correlations of .68, .50, and .35) than they do with either their fathers' education (.43, .35, and .21) or occupation (.48, .44, and .29; Jencks et al., 1972, pp. 322, 337). The same predictive superiority of IQ over family background is found for the social pathologies, too (Herrnstein & Murray, 1994; Hirschi & Hindelang, 1977; see also Gordon, 1997).

Third, most differences in both IQ and adult success occur among siblings in the same household, not between families (e.g., Jensen, 1980, p. 43, on IQ). Class-based theories of inequality do not discuss and cannot explain the large differences in life chances among siblings growing up in the same home, but *g* can. IQ differences among siblings produce essentially the same degree of inequality in adult success and pathology among the siblings as do comparable IQ differences among strangers (Murray, 1997, 1998; Olneck, 1977, pp. 137–138).

Finally, adult socioeconomic outcomes are themselves at least moderately to highly genetically heritable: 60%–70% for years of education completed, 50% for occupation level, and 40%–50% for earnings in recent studies (e.g., Lichtenstein & Pedersen, 1997; Rowe, Vesterdal, & Rodgers, 1998). Diplomas and jobs are obviously not encoded in the genes, but traits that help one gain them are. Multivariate genetic analyses have begun to isolate what those helpful personal traits are, and *g* is clearly one of them. From one half to two thirds the heritability of the three socioeconomic outcomes overlaps the heritability of IQ. That is, *g* and socioeconomic success are influenced by some of the same genes. About 40%, 25%, and 20% of total observed (phenotypic) variation, respectively, in education, occupation, and earnings can be linked to genetic differences in *g*.

Relation of *g* to Functional Literacy in Everyday Life

Many tasks performed in everyday life are the same as ones performed on jobs, from driving and cooking to planning and advising, so one might expect *g* also to predict the quality of self-maintenance and self-care in daily life—but again, especially when daily tasks are more complex. I begin with the myriad mundane tasks that citizens face in any modern, literate society.

Researchers and policy makers have long considered the seemingly low levels of functional competence in large segments of the population a threat to social equality and national productivity as well as to the well-being and civic involvement of the individuals involved (Stedman & Kaestle, 1987; Sum, 1999). They refer to such competence as functional *literacy* because it has typically been measured with written materials: "using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential" (Kirsch, Jungeblut, Jenkins, & Kolstad, 1993, p. 2). Indeed, most people in literate societies take it for granted that the conduct of daily affairs frequently requires reading and writing, and all the more so in the new information age.

Particularly good data on functional literacy have been collected for the U.S. Department of Education in the National Adult Literacy Survey (NALS; Kirsch et al., 1993). This large national survey of adults aged 16 and older measured performance on simulated daily tasks involving written materials, such as finding a given intersection on a map, calculating a tip for a meal or the cost of carpet for a room, understanding a sports article in the newspaper, and filling out a bank deposit slip or catalog order form. These are highly instrumental tasks that need not involve interpersonal contact and thus represent only a subset of life's many daily tasks. They do constitute, however, a sample of tasks that are often considered essential for one to participate effectively in modern life, which is precisely why they were measured in the first place.

The Psychometric Properties of NALS Functional Literacy Mimic Those of g

NALS researchers neither designed nor interpret the NALS as an intelligence test. Indeed, they intended it to measure three independent forms of everyday literacy: prose, document, and quantitative. They nonetheless inadvertently created a fairly good test of *g* from the materials of everyday life (given the caveat, which would apply to any test using language, that its results may validly reflect achievement but not necessarily aptitude among nonnative speakers).

First, the guidelines for developing the NALS resembled those for creating a test of general intelligence. For instance, the NALS was intended to measure "complex information-processing skills" that "go beyond simply decoding and comprehending text" by sampling a "broad range" of tasks that cover a variety of "universally relevant contexts and contents" and which can be "arrayed along a continuum" of difficulty (A. Campbell, Kirsch, & Kolstad, 1992, p. 418). Second, the family of related tests for elementary and high school students—the National Assessment of Educational Progress (NAEP) in reading—shows the same population growth curves in reading as found for intelligence (Carroll, 1987; Ralph, Keller, & Crouse, 1994).

Third, early analyses indicated that NALS literacy is actually highly general in nature, which led NALS analysts to begin describing it as "problem solving," "complex information processing" (Venezky, Kaestle, & Sum, 1987, pp. 25 and 28, respectively) and "verbal comprehension and reasoning, or the ability to understand, analyze, interpret, and evaluate written information and apply fundamental principles and concepts" (Baldwin, Kirsch, Rock, & Yamamoto, 1995, p. xv). All these skills are prototypical manifestations of *g*. Indeed, researchers eventually discovered that the three NALS scales measure only a single general factor (Reder, 1998).

Fourth, careful task analyses of the NALS test items revealed that they are graduated in difficulty, nearly identically so within all three scales, according to their processing complexity, not their readability per se (Kirsch & Mosenthal, 1990). From 84% to 89% of variance in item difficulty was accounted for by three aspects of items: type of match (e.g., whether an inference is required to locate the specified information), amount and plausibility of distracting information, and abstractness of information to be located. It is not surprising that comprehension is no better when people are given NALS test items orally (Kirsch & Jungeblut, 1990, Chapter XIII), as is the case with work literacy, too (Sticht, 1975). The complexity of information, not its mode of delivery, is apparently as much the active ingredient in NALS literacy tests as in IQ tests. In short, the NALS test of functional literacy appears to measure almost nothing but *g*, at least in native-born populations.

The Correlations of NALS Functional Literacy With Socioeconomic Outcomes Mimic Those of g

Table 1 gives rates of diverse unfavorable adult outcomes—having a weak attachment to the labor force, using food stamps, living in poverty, and not having a high-level job—for each of the five NALS literacy levels in the general population of Americans aged 16 and older. Although incidence rates for these outcomes often differ, they always rise steadily at successively lower levels of literacy. The shifts in incidence are large, which NALS analysts regard as evidence that literacy has big effects on life chances (cf. Berlin & Sum, 1988, on the effects of poor basic skills).

If NALS literacy really reflects *g*, then comparable data for IQ should reveal the same pattern of effects. Table 2 shows that they do. The samples in Tables 1 and 2 are fairly different in terms of age, how the populations were segmented into skill levels, and outcomes included, but the two sets of results nonetheless form the same pattern. In both cases, risk steadily rises as one goes down the cognitive continuum. Where outcomes can be directly compared (not being in the labor force, living in poverty), the percentages of persons affected are similar.

Gradients of risk (i.e., shifts in risk from one cognitive level to another) are best compared, however, by calculating some measure of *relative risk*. Epidemiologists commonly use the odds ratio

Table 1
Relative Risk of Unfavorable Outcomes Associated With Lower Literacy on the National Adult Literacy Survey (NALS): Prevalence (%) and Odds Ratios (ORs) for Adults Aged 16 and Over

	Prose literacy level				
Outcome	1 (≤ 225) 21%	2 (226–275) 27%	3 (276–325) 32%	4 (326–375) 17%	5 (376–500) 3%
Employed only part time					
%	70	57	46	36	28
OR	2.7	1.6	1.0	0.7	0.5
Out of labor force					
%	52	35	25	17	11
OR	3.2	1.6	1.0	0.6	0.4
Uses food stamps					
%	17	13	6	3	1
OR	3.2	2.3	1.0	0.5	0.2
Lives in poverty					
%	43	23	12	8	4
OR	5.5	2.2	1.0	0.6	0.3
Employed not as professional or manager					
%	95	88	77	54	30
OR	5.6	2.2	1.0	0.4	0.1

Note. Ranges represent scores on the NALS test. Percentages are from Kirsch, Jungeblut, Jenkins, and Kolstad (1993, Table 1.1A, Figures 2.5, 2.6, 2.7, 2.9, and 2.10). From "*g*: Highly General and Highly Practical" (p. 364), by L. Gottfredson, in *The General Intelligence Factor: How General Is It?* by R. J. Sternberg and E. L. Grigorenko (Eds.), 2002, Mahwah, NJ: Erlbaum. Copyright 2002 by Erlbaum Associates, Inc. Reprinted with permission.

(OR) for this purpose. It quantifies the level of risk associated with being a member of one risk category rather than another, such as with having a low rather than average IQ or a low rather than high income. The OR is just the ratio of two odds: (a) The numerator is the proportion of people in the target group who are affected (here, the failures) divided by the proportion who are not affected (the successes), and (b) the denominator of the ratio is the analogous proportion calculated for the comparison group. ORs therefore quantify a target group's risk relative to some pertinent comparison group. In Table 1 it is individuals with intermediate NALS scores (Level 3), and in Table 2 it is persons of average IQ (IQ 90–110). ORs of 2.0 and 4.0 represent, respectively, moderately strong and strong risk factors (Gerstman, 1998, pp. 127–128).

An example will help. In the third row of Table 1, the OR of 3.2 means that the odds of encountering a person who uses food stamps rather than one who does not is 3.2 times higher among persons scoring at NALS Level 1 (OR = 3.2) than among persons at Level 3 (OR = 1.0). In contrast, the balance of use to nonuse among the most literate persons (Level 5) is only one fifth as large (OR = 0.2) as in the comparison group (Level 3). Relative risk of using food stamps is thus 16 times higher for the least literate than the most literate (3.2 vs. 0.2).

If we now compare the risk gradients across Tables 1 and 2, we see that the gradients of relative risk associated with NALS literacy trace the same pattern as do the risk gradients associated with IQ. IQ and NALS behave like the same phenomenon with different names. The risk gradients for both are fairly linear, shallow for current attachment to the labor force, and much steeper for longer term outcomes such as occupation level and living in poverty. Even the absolute levels of relative risk are of the same order of magnitude when the same outcome is considered (e.g., being out of the labor force or living in poverty), despite one sample being older and more racially diverse than the other.

The bottom two rows of Table 2 also illustrate an earlier point, which is that IQ differences have essentially the same effect on adult success whether or not people grow up in the same household. The data in these two rows are for pairs of siblings growing up together in intact, nonpoor households, where one sibling is average in IQ and the other falls into either a lower or a higher IQ category. The data show the IQ-related relative risks of not obtaining a college degree or a professional occupation. These two OR gradients for siblings are much the same as those for similar outcomes in the broader samples: not having a high school diploma (in the top panel of Table 2) and not having a high level job (Table 1).

Functional Literacy Has a Linear and Prima Facie Relation to Life Outcomes

NALS analysts take it as self-evident that having to struggle to perform the simplest, most taken-for-granted requirements of life in a free and literate society constitutes an enormous handicap. They have stated specifically that the roughly 48% of American adults scoring no higher than Levels 1 or 2 on the NALS do not have skills adequate for "competing successfully in a global economy and exercising fully the rights and responsibilities of citizenship" (Baldwin et al., 1995, p. 16). At Level 2 literacy, individuals are routinely capable of accomplishing tasks no more difficult than locating a specified intersection on a map, entering background information on an application for a social security card, and determining the price difference between two show tickets. People at Levels 1 and 2 are not routinely able to do things like write a brief letter explaining an error in a credit card bill or use a flight schedule to plan travel arrangements (Level 3), restate an argument made in a lengthy news article or calculate the money needed to raise a child on the basis of information in an article (Level 4), or

Table 2
Relative Risk of Unfavorable Outcomes Associated With Lower IQ: Prevalence (%) and Odds Ratios (ORs) for Young White Adults

Outcome	IQ level ≤ 75 (5%)	76–90 (20%)	91–110 (50%)	111–125 (20%)	> 125 (5%)
Bell curve data: General population[a]					
Out of labor force 1 or more mo/yr (men)					
%	22	19	15	14	10
OR	1.6	1.3	1.0	0.9	0.6
Unemployed 1 or more mo/yr (men in labor force)					
%	12	10	7	7	2
OR	1.8	1.5	1.0	1.0	0.3
Chronic welfare recipient (women)					
%	31	17	8	2	0
OR	5.2	2.4	1.0	0.2	0.05[b]
Had illegitimate children (women)					
%	32	17	8	4	2
OR	5.4	2.4	1.0	0.5	0.2
Lives in poverty as an adult					
%	30	16	6	3	2
OR	6.7	3.0	1.0	0.5	0.3
High school dropout					
%	55	35	6	0.4	0.0
OR	19.0	8.4	1.0	0.1	0.0
Bell curve data: Sibling pairs[c]					
Not working in professional job					
%	100	99	98	92	77
OR		2.0	1.0	0.2	0.1
Not a college graduate					
%	100	97	81	50	18
OR		7.6	1.0	0.2	0.1

Note. Blank cells indicate that OR is very high but cannot be calculated because the odds of 100:0 (its numerator) cannot be calculated. mo/yr = months per year. From "*g*: Highly General and Highly Practical" (p. 373), by L. Gottfredson, in *The General Intelligence Factor: How General Is It?* by R. J. Sternberg and E. L. Grigorenko (Eds.), 2002, Mahwah, NJ: Erlbaum. Copyright 2002 by Erlbaum Associates, Inc. Reprinted with permission.
[a] Percentages are from Herrnstein and Murray (1994, pp. 132–194). [b] Assuming that the percentage is rounded to zero from 0.4, which yields odds of .004 and an OR of .046. [c] Percentages are from Murray (1997).

summarize two ways that lawyers challenge prospective jurors (on the basis of a passage discussing such practices) or use a calculator to determine the total cost of carpet to cover a room (Level 5).

Moreover, the analysts note, the monotonic relation between NALS scores and socioeconomic outcomes shows that successively higher levels of literacy confer successively greater advantage: "Literacy is a currency not only in our schools, but in our society as well; and, as with money, it is better to have more literacy than less" (Kirsch & Jungeblut, 1990, p. V-12). The same linearity of effect is found for *g* and job performance: Successively higher levels of *g* predict successively higher average levels of job performance.

Functional Literacy Measures Highly General Skills and Abilities

Because most people can be taught how to fill out forms, read maps, and the like, many analysts seem to assume that the functional literacy measured by such NALS items must also be highly responsive to instruction and so does not reflect a stable, underlying trait. However, the NALS items are merely a small sample of many such tasks in daily life, and what they gauge is the likelihood of a person having mastered (at 80% proficiency) the larger population of tasks of like difficulty. Recall that their difficulty rests in their information-processing complexity, not their manifest content.

The teachability of highly specific individual skills is therefore no guide to the teachability of a general underlying ability that promotes unassisted learning and the effective deployment of a whole panoply of such skills in natural settings. In fact, military training programs that were intended to raise work literacy were able to improve performance on specific work literacy tasks but did little or nothing to improve general literacy (Sticht, Armstrong, Hickey, & Caylor, 1987, Chapter 9). Not all individuals learn equally well when exposed to the same instruction, because higher *g* promotes faster, more extensive, and more complete learning of what is being taught (Schmidt & Hunter, 2004; Sticht, 1975). Perhaps more important in the current context, higher *g* also confers an advantage when individuals must learn and figure out things on their own, unassisted, whenever new demands and opportunities present themselves posttraining, as they inevitably do (Schmidt & Hunter, 2004). The relative advantage of higher *g* increases as those novel demands and opportunities become more complex, as we saw in the job performance literature.

Adults are expected to be, and must be, reasonably self-governing and self-instructing. The NALS reflects individual differences in how well people have mastered a wide variety of mostly uninstructed skills and knowledge that are broadly available in the culture. Higher literacy can be expected to be all the more useful when cultural knowledge shifts rapidly, as it typically does in politics, technology, medicine and health, and other matters of broad public interest.

Small g-Related Effects Cumulate and Snowball Into Bigger Ones

NALS research adds a link in the presumptive causal chain between *g* and socioeconomic well-being by showing how information processing demands suffuse the many mundane activities required for daily self-maintenance and participation in the larger culture. But it also helps to illustrate a less obvious phenomenon—the compounding of small effects—that will be very important in later discussions of chronic disease and accidental injury.

Why one person rather than another misreads a particular bus schedule on any particular day has many causes and is probably little related to individual differences in *g*. Nor is such misreading, by itself, likely to be particularly consequential. The crucial point, however, is that *g*'s effects are pervasive and consistent. As gambling houses know well, even small odds in one's favor can produce big profits in the long term when they remain consistently in one's favor and other influences are more erratic. Information processing is involved in all daily tasks, even if only to a minor degree, so higher *g* always provides an edge, even if small. In contrast, other influences (fatigue, advice, etc.) tend to be more volatile and haphazard, and thus are likely to cancel each other out over time. As the NALS data illustrate, people with higher literacy (*g*) tend to perform better on all literacy tasks, whether they involve dealing with banks, restaurants, or social service agencies, deciphering financial options, or engaging rights and duties as a citizen. People who plan and budget somewhat less well will find themselves slowly slipping behind others who started with the same material resources. People who less often grasp information about their educational, employment, financial, and political options or who make more numerous or more serious mistakes in following the steps and filling out the forms necessary to implement them gradually foreclose opportunities they see others taking. When this slippage occurs in many realms of life, it compounds. When an influence is ubiquitous, it can therefore outweigh all others in the long run, even episodically stronger ones, that are less consistent or less consistently useful (help, contacts, extraverted personality, strong interest, etc.).

In fact, this is the statistical phenomenon that explains why adding more items to a mental test will increase its reliability. It also explains why even test items with only faint *g* loadings (meaning that *g* is only a small factor in correctly answering any particular one of them) can, when sufficient in number, yield a test that measures almost nothing but *g* (Lubinski & Humphreys, 1997, pp. 163–165).

To summarize, the isomorphism in both form and effect for NALS literacy and *g* (their "functional equivalency"; Lubinski & Humphreys, 1997, p. 164) suggests that functional literacy is, indeed, mostly *g* and that *g* has pervasive effects both on near-term daily self-maintenance and on more cumulative life outcomes.

The Remarkably General Relation Between Social Class and Physical Health

Misreading a map or train schedule may be a nuisance, but misreading a prescription label can be a hazard. Such problems are the focus of health literacy researchers, who have independently confirmed that inadequate thinking skills impede effective self-care. They have also shown how seemingly minor inadequacies can cumulate into big health problems. Health psychologist Taylor (1991) has pointed to the importance of intelligence for health self-care:

> Factors that influence patients' ability to understand and retain information about their condition include intelligence and experience with the disorder. Some patients are not intelligent enough to understand even simple information about their case, and so even the clearest explanation falls on deaf ears. (p. 310)

However, differences in *g* rarely figure in explanations of ill health or differentials in rates of ill health, despite the large differences in *g* both within and between groups. Individuals within the normal range span four standard deviations, from borderline retarded (IQ 70) to borderline gifted (IQ 130). Table 3 shows that the average IQ differences between occupational and educational groups are also substantial. The adjacent groups overlap a lot in IQ, but their averages usually differ by one third to one half standard deviation. The top and bottom occupational categories differ by about 1.3 standard deviations (22 IQ points), and the

Table 3
Average IQ of Different Occupational and Educational Groups in a Representative Sample of Adults Aged 16–74

Variable	IQ *M*	IQ *SD*
Occupation		
Professional and technical	111.00	13.43
Manager, clerical, sales	104.13	12.58
Skilled workers	99.49	12.56
Semiskilled workers	93.06	14.16
Unskilled workers	89.07	15.16
Not looking for work	98.85	15.56
Education		
16+ years (college graduate)	115.17	12.20
13–15 years	107.32	11.05
12 years (high school graduate)	100.04	12.49
9–11 years	96.41	14.21
8 years	90.82	12.00
0–7 years	82.48	14.31
Total	99.81	15.11

Note. Data are from "Demographic Characteristics and IQ Among Adults: Analysis of the WAIS-R Standardization Sample as a Function of the Stratification Variables," by C. R. Reynolds, R. L. Chastain, A. S. Kaufman, and J. E. McLean, 1987, *Journal of School Psychology, 25,* p. 327. Copyright 1987 by Elsevier. Reprinted with permission.

top and bottom educational categories by over 2 standard deviations (33 IQ points).

The Poverty Paradigm Cannot Explain Social Class Differences in Health

Age-specific rates of illness and death are often two to three times higher for individuals in the lower social strata. For many years the so-called poverty paradigm has dominated thinking about why such disparities exist. Under this paradigm, the disparities are presumed to result from differences in access to health care and other such resources (Hummer, Rogers, & Eberstein, 1998). "Wealth Secures Health," as a recent headline in the *APA Monitor* put it (Clay, 2001). Social class is typically measured by level of education, occupation, income, or some combination thereof (Dutton & Levine, 1989). The poverty paradigm has foundered, however, on a growing number of contrary facts and vexing paradoxes, many of them pointed out decades ago (Kitagawa & Hauser, 1973; Syme & Berkman, 1976).

Prominent among the challenging facts is that the paradigm's key health resource—greater access to medical care—has surprisingly little relation to differences in health. The introduction of Medicaid and Medicare in the United States during the 1960s soon led to the poor making as many physician visits per year as the nonpoor, but large class differentials in health remained—even when the poor began to visit physicians at a higher rate than the nonpoor (Rundall & Wheeler, 1979, p. 397). Great Britain and other countries that had expected to break the link between class and health by providing universal health care were dismayed when the disparities in health not only failed to shrink but even grew (see *The Black Report* by Townsend & Davidson, 1982; also Link & Phelan, 1995, p. 86; Marmot, Kogevinas, & Elston, 1987, p. 132; Susser, Watson, & Hopper, 1985, p. 237).

It is now amply documented, first, that equalizing the availability of health care does not equalize its use. Perhaps most important, less educated and lower income individuals seek preventive health care (as distinct from curative care) less often than do better educated or higher income persons, even when care is free (Adler, Boyce, Chesney, Folkman, & Syme, 1993; Goldenberg, Patterson, & Freese, 1992; Rundall & Wheeler, 1979; Susser et al., 1985, p. 253; Townsend & Davidson, 1982, Chapter 4).

Second, greater use of medical care does not necessarily improve health (Marmot et al., 1987, p. 132; Valdez, Rogers, Keeler, Lohr, & Newhouse, 1985). To illustrate, when a large, federally funded, RAND-conducted, randomized controlled experiment tested the effects of subsidizing health care costs at different levels in six cities across the United States, participants with free care used more medical care than those with only partly subsidized care, but their health was no better after 2 years. Participants with free care had indiscriminately increased their use of inappropriate as well as appropriate care (Lohr et al., 1986, p. 72). Prenatal care provides another example that more care does not necessarily produce better outcomes, in this case for newborns (Fiscella, 1995).

Third, health depends more now than ever on private precaution and health lifestyle. The American Psychological Society (APS) noted in its 1996 Human Capital Initiative report on health (APS, 1996) that "seven of the 10 leading causes of death have aspects that can be modified by doing the right thing; that is, by making healthy choices about our own behavior" (p. 5) and that mortality "could be reduced substantially if people at risk would change just five behaviors: Adherence to medical recommendations (e.g., use of antihypertensive medication), diet, smoking, lack of exercise, and alcohol and drug use" (p. 15).

It went on to describe how "doing the right thing" not only helps prevent the onset of disease, but also can "reduce the pain and progression of some diseases" and "determine whether the illness will be devastating or whether quality of life can be preserved or extended" (p. 9). According to the 1979 Surgeon General report, health self-care is even more important than medical care (U.S. Department of Health, Education, and Welfare, 1979):

> Beginning in early childhood and throughout life, each of us makes decisions affecting our health. They are made, for the most part, without regard to, or contact with, the health care system. Yet their cumulative impact has a greater effect on the length and quality of life than all the efforts of medical care combined. (p. 10-1)

The "paradox," Susser et al. (1985) noted, is that increased public health efforts at "prevention in many instances ha[ve] widened the disparity in health between the social classes," perhaps because "new preventive techniques have turned on personal behavior [e.g., not smoking] rather than on social engineering [e.g., controlling infectious disease by providing clean water and requiring immunizations for school entry]" (p. 254).

Epidemiologists Now Search for a More General Fundamental Cause of Health Inequalities

For decades, social epidemiologists have puzzled over what many of them continue to label an "extraordinary" or "remarkable" fact (e.g., Cassel, 1976, p. 110; Dutton & Levine, 1989, p. 32; Link, Northridge, Phelan, & Ganz, 1998, p. 375; Marmot et al., 1987, p. 111; Syme & Berkman, 1976, p. 2), namely, the relation between socioeconomic level and health status is so remarkably general. With few exceptions, it is found for all major diseases and causes of death and for all ages, sexes, races, decades, and countries, despite obviously different health risks and needs in different times, places, and populations (Adler & Ostrove, 1999; Hertzman, 1999, pp. 25–26).

This puzzle is compounded by the "mystery of the SES–health gradient" (Adler et al., 1994, p. 22), which is that rates of illness and death are successively lower at successively higher rungs on the social ladder, and the monotonic decrease continues even among strata above the threshold of material resources required for adequate care. Moreover, the finely graded relation between class and health is found regardless of whether social class is measured by level of education, occupation, or income (Adler et al., 1993; Dutton & Levine, 1989), although education generally yields the tighter fit (e.g., Call & Nonnemaker, 1999, for adolescents' self-ratings of health; Cramer, 1987, for infant mortality; Hayward, Crimmins, Miles, & Yang, 2000, for 22 varied disabilities, diseases, and impairments among adults aged 51–61; Pincus, Callahan, & Burkhauser, 1987, for 23 chronic diseases among adults aged 18–64). Although the SES–health relation often varies in strength, it is as clear in countries that provide universal health insurance as in those that do not, for diseases that are amenable to medical treatment as for those that are not, and for objective as well as subjective reports of illness (Adler et al., 1993, p. 3141; Dutton & Levine, 1989; Marmot et al., 1987).

Diseases involving different organ systems and with seemingly different etiologies nonetheless tend to be related in the same manner to social class. For example, a national sample of 10,538 adults aged 18–64 in 1978 yielded relative risk ratios between about 2.0 to 3.0 for cardiovascular, gastrointestinal, musculoskeletal, pulmonary, renal, and other diseases for adults with 1–8 years of education compared with those with 12 years (ORs not shown, but calculated from Pincus et al., 1987, p. 870). Neoplastic (cancerous) and psychiatric illnesses were, respectively, less strongly and more strongly related to education level, the relevant ORs being 1.2 and 5.5 for adults with 1–8 years of education. Relative risk for persons with more than 12 years of education was only about 0.7 for most of the diseases. All disease categories except neoplasms showed a dose–response relation (i.e., rates increased steadily at lower levels of education), and all diseases except neoplasms remained significantly related to education level after age, sex, race, and smoking were controlled for (Pincus et al., 1987). Even identical medical treatment for identical problems of equal severity yields SES–mortality gradients, as seen in a study of cancer survival in Boston (Syme & Berkman, 1976).

Prevalence rates and disease profiles often differ by sex and race, and they have tended to change over time in all demographic groups, but the SES–health relation still pervades them all (Adler et al., 1993; Hayward et al., 2000; Marmot et al., 1987). Table 4 illustrates this. The diseases in this table are more specific than the ones just discussed, and age, sex, and smoking have all been controlled. The prevalence rates are estimates, based on incidence rates by age in the cohort, of what proportion of the people who are disease free at age 51 will have the disease by age 63. The table therefore excludes people who already have the disease by age 51 (and thus proportionately more individuals from the lower classes). As Table 4 shows, prevalence rates sometimes differ a lot by race (diabetes, hypertension) and somewhat by sex (diabetes, heart, hypertension, and stroke). Education (and thus *g*, its strong correlate) cannot explain differences between the sexes nor many of them between the races, but it seems to operate in an identical manner within all the sex–race groups for any particular disease. This is seen in the high similarity of risk gradients across the four race–sex groups for any particular disease. Moreover, the gradients for five of the six diseases are themselves similar, with ORs ranging from about 2.0 to 0.5 across the education levels for the first two and from 1.5 to 0.7 for the next three. A similar gradient for the sixth, neoplasms, disfavors more educated persons.

The same generality is found across countries as well. The major causes of death and disease can differ considerably across countries, and the particular mediators of the SES–health relation within countries thereby differ too (sanitation mediates rates of infectious disease in poor countries, but lifestyle mediates rates of chronic disease in rich countries, where deadly infectious diseases are no longer common)—yet the SES–health gradient endures (Adler et al., 1993, pp. 3140–3141). As already noted, improvements in a country's overall health for any reason are often followed by bigger, not smaller, class disparities in health because health improves at a faster rate among the higher classes (Dutton & Levine, 1989, pp. 34–36; Pappas, Queen, Hadden, & Fisher, 1993; Steenland et al., 2002). The SES–health gradients for some diseases (e.g., coronary heart disease, polio, malignant melanoma) have sometimes favored the least over the most advantaged but then reversed, and others (e.g., breast cancer) still disadvantage the more educated but are becoming unstable and may reverse in time (Adler et al., 1993; Dutton & Levine, 1989; Link & Phelan, 1995; Marmot et al., 1987; Pearce, Davis, Smith, & Foster, 1983; Susser et al., 1985).

A specific example illustrates this as well as the point that SES gradients for health behaviors (e.g., smoking, seeking readily available preventive care) are also ubiquitous (Centers for Disease Control and Prevention, 1994) and can produce new class-related disparities in health in the wake of new technologies. Specifically, the mortality from cervical cancer dropped greatly after the invention of the Pap smear early in the 20th century, but an SES gradient soon developed because better educated women sought the diagnostic exam in greater proportion and still do.

Because the SES–health relation is so enduring and so remarkably general in the midst of diversity and change, SES–health researchers suggest that "it is plausible to infer that a generalized susceptibility to disease is a condition of lower-class life" (Susser et al., 1985, pp. 253–254; see also Cassell, 1976; Marmot, Shipley, & Rose, 1984, p. 1003).

> That so many different kinds of diseases are more frequent in lower class groupings directs attention to generalized susceptibility to disease and to generalized compromises of disease defense systems. . . . [There may be] something about life in the lower social classes [that] increases vulnerability to illness in general. (Syme & Berkman, 1976, p. 5)

Researchers have therefore begun to look for an equally general fundamental cause—some higher order variable or transportable resource (e.g., Adler et al., 1994; Hayward et al., 2000)—that maintains the SES–health relation in a "dynamic system in which risk factors, knowledge of risk factors, treatments, and patterns of disease are changing" (Link & Phelan, 1995, p. 88).

The poverty paradigm has never developed a theory to explain the general relation it continues to describe (Hummer et al., 1998, p. 555; Mechanic, 1989, p. 20), perhaps partly because its different indicators of SES measure nothing obviously in common. Education is said to provide, among assorted other advantages, improved employment, gathering of information, health behavior, and negotiation of one's way through the health system, whereas income allows purchase of better health care, nutrition, transportation, and housing (Hummer et al., 1998, p. 560; Mechanic, 1989, pp. 10–22). Recent discussions of what the fundamental cause might be have included social support, social connectedness, social anxiety, chronic stress (allostatic load), sense of personal control or mastery, experience of control, self-esteem, nutrition, relative deprivation, stigmatization, self-perceived social status, resistance resources, coping strategies, and intrinsic problem-solving capacities (Adler et al., 1994; Adler & Snibbe, 2003; Clay, 2001; Dutton & Levine, 1989; Link & Phelan, 1995; Marmot et al., 1987; Pincus et al., 1987; and many papers in Adler, Marmot, McEwen, & Stewart, 1999). To my knowledge, none has been shown plausible for explaining the full pattern—especially the generality and occasional reversal—of class disparities across time, place, and disease.

Table 4
Cumulative Probability (Percentage) and Relative Risk (Odds Ratio) of Disease Onset by Age 63 for Persons Age 51 Without the Disease

	Years of education					
	White			Black		
Variable	8	12	16	8	12	16
Average IQ	95[a]	101	112[b]	84[a]	91	96[b]
*SD*s from White mean IQ	−0.5	0	0.7	−1.2	−0.7	−0.4
Men						
Diabetes						
%	27.3	16.0	9.4	65.5	38.7	22.7
OR	2.3	1.0	0.5	3.0	1.0	0.5
Chronic obstructive pulmonary disease						
%	23.1	12.9	7.2	24.0	13.4	7.5
OR	2.0	1.0	0.5	2.0	1.0	0.5
Stroke						
%	7.9	5.3	3.6	17.9	12.1	8.1
OR	1.5	1.0	0.7	1.6	1.0	0.6
Heart						
%	31.5	23.5	17.5	33.8	25.2	18.8
OR	1.5	1.0	0.7	1.6	1.0	0.8
Hypertension						
%	36.0	29.8	24.0	57.6	47.1	38.5
OR	1.3	1.0	0.7	1.5	1.0	0.7
Cancer						
%	5.4	7.2	9.5	4.0	5.3	7.0
OR	0.7	1.0	1.3	0.7	1.0	1.3
Women						
Diabetes						
%	20.3	11.9	7.0	49.0	28.9	16.9
OR	1.9	1.0	0.6	2.4	1.0	0.5
Chronic obstructive pulmonary disease						
%	23.0	12.8	7.1	24.0	13.4	7.4
OR	2.0	1.0	0.5	2.0	1.0	0.5
Stroke						
%	5.8	3.9	2.6	13.1	8.8	5.9
OR	1.5	1.0	0.7	1.6	1.0	0.7
Heart						
%	27.0	20.2	15.0	29.0	21.7	16.1
OR	1.5	1.0	0.7	1.5	1.0	0.7
Hypertension						
%	41.6	34.0	27.8	66.4	54.3	44.7
OR	1.4	1.0	0.8	1.7	1.0	0.7
Cancer						
%	5.6	7.5	10.0	4.1	5.5	7.3
OR	0.7	1.0	1.4	0.7	1.0	1.4

Note. The table represents hypothetical disease experiences calculated from the parameter estimates of hazard models. Each hazard model regresses the log of the risk of a disease onset on age, race, sex, and education. For example, "among black women with an eighth-grade education who survive to age 51 without hypertension, approximately 66 percent are expected to acquite the disease by age 63" (Hayward et al., 2000, p. 923). Average full-scale IQs are from the standardization sample of the Wechsler Adult Intelligence Scale—Revised (WAIS–R) and include persons aged 16–74 (Reynolds, Chastain, Kaufman, & McLean, 1987, p. 338). White mean IQ is 101.38, and White standard deviation is 14.67 for full scale IQ (Reynolds et al., 1987, p. 330). Standard deviation units were calculated before rounding. Data are from "The Significance of Socioeconomic Status in Explaining the Racial Gap in Chronic Health Conditions," by M. D. Hayward, E. M. Crimmins, T. P. Miles, and Y. Yang, 2000, *American Sociological Review, 65,* Table 5, p. 922. Copyright 2000 by the American Sociological Association. Reprinted with permission. OR = odds ratio.
[a] IQ is for *N*-weighted average of persons with 0–8 (IQ 89) and 9–11 years of education (IQ 98), respectively, for Whites and IQ 80 and 86, respectively, for Blacks. [b] IQ is for persons with 13–16 years of education.

g Meets Key Criteria for Being the Fundamental Cause

Certain possibilities nonetheless seem to have been peremptorily dismissed. With few exceptions (e.g., Mechanic, 2000), any suggestion that class disparities in health may be due in part to genetic-based individual differences is today disapproved as blaming the victim (e.g., Cramer, 1995, p. 234) or "absolv[ing] the social structure of responsibility" (R. Wilkinson, 1996, p. 63). Thus, although the importance of healthy behavior and lifestyle is acknowledged, and although some authors suggest that problem solving in particular may be important, they generally state that differences in any of these personal attributes would themselves be caused by differences in individuals' external social conditions (e.g., Cramer, 1995, on externally generated "mothercraft"). Just as exposure to environmental toxins is presumed to be involuntary, so is "self-damaging" behavior said to result from individuals being "hostage to custom" (Susser et al., 1985, p. 253). Some analysts even reject as risky the recent emphasis on understanding the class-related proximate influences on health, such as smoking and diet, that might mediate the SES–health relation because such emphasis might "play into the hands" of those who do not subscribe to the "social origins of risk" (Link & Phelan, 1995, pp. 84–85). One article that does suggest intelligence is "plausible" as the general cause then quickly dismisses it as "improbable," largely on the authors' (mistaken) impression that intelligence does not correlate with patient compliance (Adler et al., 1994, p. 17).

But is *g* so improbable? Data relating intelligence directly to health are relatively scarce (cf. O'Toole & Stankov, 1992), partly because mental test scores are much less readily available than indicators of social class. But several large epidemiological studies suggest that *g* is, in fact, a viable candidate. For example, a 1933 study of 273 predominantly White health areas in New York City (Maller, 1933) found that the average IQ of a health area's school children ranged from 74 to 118. These average IQs correlated −.43 with the neighborhood's rate of death, −.51 with infant mortality, and −.57 with juvenile delinquents arraigned in court. Maller (1933) concluded, in part on the basis of a factor analysis (tetrad analysis) of these and several other vital indices, that neighborhoods were aligned along a general factor that he labeled "developmental status of the group" (p. 116). "Desirable characteristics seem to go together. Areas that excel in 'vitality' tend also to excel in intelligence and scholastic attainment and social adjustment" (p. 121).

A second large study, the Australian Veterans Health Studies (AVHS) Mortality Study, looked at IQ at the individual level. It examined the relation of 57 psychological, behavioral, health, and demographic variables to noncombat deaths among 2,309 Australian soldiers conscripted during the Vietnam War (O'Toole & Stankov, 1992). Prior IQ, which was measured at induction by the Army General Classification (AGC) test (see O'Toole & Stankov, 1992), was an important predictor of mortality by age 40. When all other factors were controlled, each additional IQ point was associated with a 1% decrease in risk of death (O'Toole & Stankov, 1992, p. 711). The chief predictors of mortality differed, however, for the two major causes of death in this sample of young men, motor vehicle accidents (MVAs) and suicide. Regression analyses showed that IQ was definitely the most important predictor of MVA deaths, whereas psychiatric and conduct problems (e.g., going absent without leave) had no significant predictive value. In contrast, both IQ and psychiatric/conduct problems were important predictors of death by suicide. Post high school education was the only other variable of the 57 that added further to the prediction of either MVA deaths or suicide, although not by much.

Another large longitudinal study looked at the precursors of low birth weight, which is of particular concern because of its strong link to infant mortality (Cramer, 1995). This study used the same national data from which the rates of social pathology in Table 2 were derived. Mother's prior IQ (Armed Forces Qualifying Test score; Cramer, 1995) had a significant relation with baby's weight at birth, but income had none after IQ was controlled for.

Although such studies are suggestive, what criteria would *g*—or any other candidate—have to meet to qualify as a plausible fundamental cause?

1. Stability: Distribution of causal agent is stable over time. Any deep and consistent force must persist across generations and also be reasonably stable over the course of an individual's life. Otherwise, its pattern of effects would not be so remarkably general over decades and ages. *g* meets this test, because large and stable individual differences in *g* develop by adolescence and because the same wide dispersion (inequality) in IQs is found in every successive generation, even when social conditions change. Equalizing socioeconomic environments does little or nothing to reduce the dispersion in IQ, as was illustrated by the great variation in intellectual capacities among children born in post-WWII Warsaw despite the city's Communist government providing the same (integrated) housing, medical care, and other amenities to all inhabitants (Firkowska et al., 1978). Studies of adopted siblings tell the same story: Despite growing up together, they are no more similar in IQ by adolescence than are strangers (Plomin et al., 2001). The dispersion of IQ in a society is more stable than its dispersion of socioeconomic advantage.

2. Replicability: Causal agent can transmit inequality from parent to child generation, including within families. Any deep and enduring fundamental cause that remains so intimately linked with SES must not only predict adult social status (not just health) within generations but also replicate its pattern of transmission from parent to child across generations. We have already seen that prior IQ predicts individuals' later SES moderately well and better than does parents' SES. In addition, IQ differences between fathers and sons and between siblings also predict differences in the children's later social status. That is, if a son is brighter than his father, the son tends to enter a higher level occupation than the father; if he is not as bright, he tends to enter a lower level occupation (Waller, 1971). The poverty paradigm cannot explain the production of socioeconomic inequality within families, only between them. *g* can explain both. Recall that siblings who differ in IQ also differ in socioeconomic success to about the same degree as do strangers of comparable IQ (Jencks et al., 1979; Murray 1997, 1998; Olneck, 1977).

Just as important, *g*'s pattern of moderate—but only moderate—intergenerational transmission is consistent with the moderate—but only moderate—similarity in social class between parents and their adult children. The observed (and true) IQ correlation between parents and biological children is .45 (.50; Plomin & Petrill, 1997). The observed (and true) correlation between fathers' and sons' educational level is .38 (.43); for occupational level it is .37 (.44; Jencks et al., 1972, pp. 322, 337; see similar estimates by Hauser & Featherman, 1977, p. 287). *g* theory predicts that if genetic *g* is the principal mechanism transmitting socioeconomic inequality from one generation to the next, then the maximum correlation between parent and child SES will be close to their genetic correlation for IQ, which is about .50. Class-based theories make no particular prediction about the magnitude of intergenerational correlations for social class, but they do predict that the correlations will drop as family socioeconomic advantages are leveled. In fact, intergenerational SES correlations have remained surprisingly stable, despite improvements in social conditions.

3. Transportability: Causal agent has highly transportable, context-independent form of influence. As the SES–health researchers have noted, any fundamental cause must demonstrate a highly general causal mechanism and be highly transportable across life situations. *g* meets this test. The job performance and functional literacy studies both illustrated how *g* represents a set of highly generalizable reasoning and problem-solving skills. And it is very important that *g* seems to be linearly related to performance in school, jobs, and the broad societal competition to get ahead. In contrast, as noted earlier, the poverty paradigm would not predict and is therefore called into question by the "mystery of the SES–health gradient" (Adler et al., 1994, p. 22), and most of its candidate fundamental causes are neither as powerful nor as broadly transportable as is income, which itself fails the prior two criteria.

4. Generality: Causal agent exerts widespread, similar influence on manifestly dissimilar targets. A fundamental cause would also have to equal or surpass the broad generality for health already demonstrated by SES. Direct evidence for the breadth of effect for *g* is mounting. Brand's (1987) review of the diverse correlates of *g* included physical fitness, longevity, and a preference for low-sugar, low-fat diets and, in the negative direction, alcoholism, infant mortality, smoking, and obesity. Deary and his colleagues (Deary, 2000b; Deary, Whiteman, & Starr, 2004) found that IQ measured at age 11 predicted longevity, cancers, dementia, and functional independence more than 60 years later. They also found that mothers' mental ability is a strong independent determinant of glycemic control in their diabetic children (Ross, Frier, Kelnar, & Deary, 2001). There is also considerable work showing that higher *g* is a key source of psychological resilience among children raised in extremely deprived, neglectful, or abusive environments (e.g., Fergusson & Lynskey, 1996; Garmezy, 1989; Werner, 1995) and that it helps protect adults against posttraumatic stress disorder (e.g., Macklin et al., 1998; McNally & Shin, 1995). There is no large body of research relating intelligence to health that is parallel to the one for SES, so it is not possible to examine *g*'s generality in the health domain in a manner identical to that pursued for SES. Other sorts of evidence provide a way to examine it, but two additional requirements for a fundamental cause require mention before I turn to that evidence.

5. Measurability: Causal agent is amenable to empirical assessment. No fundamental cause can be proved unless a viable construct for it is developed and measured. As noted, the poverty paradigm has provided none. The conceptualization and measurement of even social class itself is still uncertain and unsystematic. In contrast, although the ultimate nature of *g* (perhaps some general property of the brain; Deary et al., 2004) has yet to be determined, *g*'s everyday manifestations (in problem solving, efficient learning, etc.) are well known. Moreover, the *g* factor can be extracted from any broad set of mental tests and has provided a common, reliable yardstick for measuring general intelligence in any population or locale.

It is important to note that research need not actually measure *g* itself to provide solid evidence about it, because there are many surrogates whose degree of *g* loadedness is known. IQ tests and most tests of academic aptitude and achievement provide imperfect but still very good measures of *g*. Other variables can be ranked in *g* loadedness and would be predicted to correlate with health outcomes in proportion to their *g* loadedness, if *g* is indeed the fundamental cause. Among the usual indicators of class, years of education is the most *g* loaded because it correlates .68 with IQ, whereas occupation and income correlate only .50 and .35 with IQ in large, fairly representative samples of men (true correlations; Jencks et al., 1972, pp. 322, 337).

6. Falsifiability: The theory behind the proposed fundamental cause must make falsifiable predictions. *g* theory would conceive health self-care as a job, a set of instrumental tasks performed by the individuals involved, so it would predict *g* to influence health performance in the same way it affects performance in education and work. For example, we would doubt that *g* is the fundamental cause if task complexity did not moderate the utility of *g* for health performance in the manner it does for job performance. It would also raise doubts to discover a threshold above which higher levels of *g* do not contribute to better health or to see health inequalities decrease rather than increase when people are more often allowed or required to exercise their own judgment in health matters—for example, when they gain more options for preventive care, physicians make fewer decisions for patients, or the media broadcast more health information. Other falsifiable predictions involve the genetics of health and IQ. For instance, multivariate genetic analyses should reveal the phenotypic correlations of *g* with individuals' health behavior and outcomes to be partly genetic (see Neiss, Rowe, & Rodgers, 2002, for such research on child bearing). The behavior genetic decomposition of mean social class differences in health should likewise reveal a sizable genetic component owing to *g*. A final example: Ensuring a basic level of material access should increase health inequalities, but ensuring basic cognitive access (e.g., help, easier instructions) should decrease them, because higher *g* persons will better exploit the former and low-*g* individuals profit most from the latter.

Relation of Health Knowledge and Health Literacy to *g*, Health, and Social Class

Let me return now to the fourth criterion for assessing whether *g* is the mysterious fundamental cause, namely, that it relate (and linearly so) to virtually all health behaviors and outcomes. I begin with two related bodies of research: health knowledge and health literacy. As I show, both attributes are highly general in nature, and both reflect the capacity for unassisted learning and problem solving that is becoming ever more important as advances in medical and health care make the job of patient ever more complex.

Health Knowledge and Its Relation to SES Are Highly General and g Loaded

Chronic diseases are the major illnesses in developed nations today, and their major risk factors are health habits and lifestyle. Individuals are thus increasingly called on to guard their own health. Although good health knowledge does not guarantee a healthy lifestyle, it may often be a necessary precondition. SES–health researchers frequently suggest that the uneven diffusion of information throughout society is partly to blame for why the SES–health relation remains strong and will probably become even stronger. This is their explanation, for example, for why rates of coronary heart disease were highest in the higher social classes when smoking and eating red meat were considered luxuries but why the SES–heart disease relation soon turned upside down when both were revealed to harm health (e.g., Adler et al., 1993, p. 3143; Link & Phelan, 1995, p. 86; Marmot et al., 1987, p. 124).

Just as research on high school students has shown that "students who are informed in academic areas tend to be informed in non-academic ones as well" (Jencks et al., 1979, p. 90), survey researchers have long noted that disparities in adults' knowledge are highly generalized. "The most striking finding is the practically unitary character of knowledge: those who are best informed about one subject are likely to be best informed about any other" (Feldman, 1966, p. 166). The highest social strata know the most, and the lowest know the least, whether class is assessed by education, occupation, or income and even when the information seems to be most useful for the poorest (e.g., price ceilings in 1942; Knupfer, 1947, p. 111).

Knupfer (1947) captured well both the generality of knowledge (and ignorance) and its relation to social class status when she detailed the "mental isolation" and "withdrawal" (p. 104) of lower status individuals from the mental life of the nation in her *Portrait of the Underdog*. Hyman and Sheatsley (1947) classified 32% of the public in 1947 as "a 'hard core' of know-nothings" that was beyond the reach of information campaigns: "*There is something about the uninformed which makes them harder to reach, no matter what the level or nature of the information*" (p. 413). Four decades later, S. E. Bennett (1988) concluded that, despite rising educational levels, "nearly 30 percent of the public continue to be know-nothings and that they remain concentrated in the same population sectors as in the 1940s" (p. 486). Survey researchers have not settled on an explanation of why the lower status person "does not see as much of what goes on around him" (Knupfer, 1947, pp. 111–112), but many point to education being "a powerful correlate of acquisition of knowledge about public affairs and science from mass media" (Tichenor, Donohue, & Olien, 1970, p. 160).

Moreover, the association of knowledge with social class seems to be stronger when the information in question is more widely publicized by the mass media (Tichenor et al., 1970). This so-called knowledge-gap phenomenon was replicated yet again in three recent mass media campaigns on environmental issues in the Netherlands (Weenig & Midden, 1997). That study also found that diffusion was "remarkably similar" (p. 955) for all three issues, that it was characterized by a monotonic, negatively accelerated growth curve, and that the less educated groups "showed no signs at all of catching up" (p. 951) with the better educated.

Feldman (1966) looked at health knowledge in particular and characterized his national survey as a case study in self-directed "adult learning" (p. 3) because "the mass media are the primary source of much of what people know about diseases" (p. 94; see also p. 136). He also noted that as the public had become better informed over time (e.g., about the warning signs of cancer), knowledge was not equalized because the previously informed had now become more fully informed. He found (Feldman, 1966, p. 116) that health knowledge is influenced to some extent by interest, gender, and age, after education is controlled, but surprisingly little by personal concern and experience with disease. Instead, he reported, education "is by far the strongest correlate" of knowledge (Feldman, 1966, p. 109). Both occupation and income, once again, were weaker correlates than education (e.g., p. 105). Education probably operates here mostly as a surrogate for *g*, because Beier and Ackerman (2003) found that knowledge of 10 different kinds of widely available health information (e.g., reproduction, aging, nutrition, safety) formed "one dominant factor" (p. 441), which in turn correlated about .90 (p. 443) with the *g* factor they derived from seven mental tests. Neither personality nor self-reported level of health knowledge had much relation to actual level of knowledge, and an education–income composite added nothing to its prediction after *g* was controlled for.

Feldman (1966, p. 97) also reviewed evidence that those who knew most before exposure to new information also gained most from the new exposure, so disparities in knowledge remained or grew. Education-related relative risk was higher for the less educated when the public as a whole was better informed about a disease. For example, in 1955, 48% of the public could name at least one symptom of diabetes, 62% could name at least one symptom of cancer, and 69% could name at least one symptom of polio (Feldman, 1966, p. 90). However, the relative risk of persons with 0–8 years of education (compared with those with 9–12 years) not being able to name even one symptom was successively higher for the better known diseases—respectively, 1.7, 3.4, and 4.4 (ORs calculated from data in Feldman, 1966, p. 102). Moreover, the risk gradient for ignorance of the signs of cancer had steepened between 1945 and 1955, from 2.3 to 3.4 for the least educated, as more citizens had learned its signs (Feldman, 1966, p. 121).

It is very important to note that Feldman (1966, pp. 140–148) also provided evidence that exposure is not just passive but that more educated people seek out and attend to more information, which is indicated by their more extensive use of newspapers, magazines, and books. NALS research shows similar differences in self-exposure (Kirsch & Jungeblut, n.d., p. 53; Kirsch et al., 1993, pp. 138–140). This is exactly the double-barreled way that higher *g* promotes more learning—it increases exposure to learning opportunities and then allows for their fuller exploitation (cf. Rodgers et al., 1994; Rowe, 1997, on passive learning theory). That adopting health innovations involves active learning rather than just passive exposure accords with evidence that patients adopt birth control (Behrman, Kohler, & Watkins, 2002) and physicians adopt new antibiotics (Burt, 1987) more because of social learning and professional decision making than mere exposure to social influence.

All the foregoing evidence suggests that education, health knowledge, and general knowledge of public affairs constitute a single loose network of mental resources, the chief element binding them together being *g*. Each measures some things beyond *g*, but learning ability (*g*) seems to be the chief active ingredient in them all.

Health Literacy Predicts Health Knowledge, Health Behavior, and Health

We have seen that people differ in access to information and health care, for reasons both within and outside their control. But what happens once all are seated in a doctor's office receiving information, one on one, that is directly pertinent to whatever problem brought them into the office? Do all profit equally? No, according to the research on health literacy. As noted earlier, some patients are unable to "understand even simple information about their case" (Taylor, 1991, p. 310). The research also graphically illustrates how such difficulty in dealing with daily health matters can precipitate longer term health problems.

Noncompliance or nonadherence to medical regimens has long vexed medical and health workers. Prescription drugs provide an example.

> Over half of the 1.8 billion prescriptions written annually are taken incorrectly by patients. . . . Because they are used improperly, an estimated 30–50 percent of all prescriptions fail to produce desired results. . . . Approximately 10 percent of all hospitalizations and 23 percent of all nursing home admissions are attributed to a patient's inability to manage or follow drug therapy. (Berg, Dischler, Wagner, Raia, & Palmer-Shevlin, 1993, p. S5)

Worse yet, one study estimated that almost 30% of patients were taking their medication in a manner that seriously threatened their health (Roter et al., 1998).

Noncompliance of all sorts is particularly a problem in low-income clinic populations, where rates frequently exceed 60% (Becker & Maiman, 1975, p. 10). Expense is seldom a barrier, but regimen complexity is (e.g., Berg et al., 1993, p. S8; Cameron, 1996; Dodrill, Batzel, Wilensky, & Yerby, 1987; Schulz & Gagnon, 1982). Noncompliance can impose high costs in morbidity and mortality, as exemplified in studies of death from myocardial infarction among heart patients in treatment (OR of 2.4 for poor adherence; Gallagher, Viscoli, & Horwitz, 1993). The problem here, then, is not lack of access to care but the patient's failure to use it effectively when delivered.

Although *noncompliance* connotes lack of motivation and is still often conceived as such, many health workers have concluded it "may not be so much a matter of willful disobedience as one of failure to understand the clinician's instructions and expectations" (Davis, Meldrum, Tippy, Weiss, & Williams, 1996, p. 94). The new field of health literacy therefore examines to what extent patients have "the ability to apply the literacy skills needed to function fully and effectively as a patient" (Davis, Meldrum, et al., 1996, p. 94). Low literacy has been associated with low use of preventive care, poor comprehension of one's illness, and delay in seeking screening for cancer, even when care is free (C. L. Bennett et al., 1998). It is especially a problem with regard to preventive care among low-income women, who, for example, underuse and know less about mammograms (Davis, Arnold, et al., 1996).

Health literacy researchers have developed a variety of tests for gauging degree of health literacy. The best is the 22-min Test of Functional Health Literacy of Adults (TOFHLA; Parker, Baker, Williams, & Nurss, 1995), which can be administered in either English or Spanish. The TOFHLA is similar to the NALS in that it simulates everyday tasks using written materials, but the materials relate specifically to health matters: labels on prescription vials, appointment slips, directions for preparing for a particular diagnostic test, hospital consent forms, and so forth. Sample items can be seen in Table 5. Like the NALS, they measure skills of prima facie practical value.

Table 5
Percentage and Relative Risk (OR) of Patients Incorrectly Answering Sample Test Items on the TOFHLA, by Level of Health Literacy

Test item	Literacy level		
	Inadequate	Marginal	Adequate
Numeracy items			
How to take medication on an empty stomach			
%	65.3	52.1	23.9
OR	6.0	3.2	1.0
How to take medication four times a day			
%	23.6	9.4	4.5
OR	6.6	2.2	1.0
How many times a prescription can be refilled			
%	42.0	24.7	9.6
OR	6.8	3.1	1.0
How to determine financial eligibility			
%	74.3	49.0	31.5
OR	9.0	3.0	1.0
When next appointment is scheduled			
%	39.6	12.7	4.7
OR	13.5	3.0	1.0
How many pills of a prescription should be taken			
%	69.9	33.7	13.0
OR	15.6	3.4	1.0
Prose items			
Instructions for preparing for upper gastrointestinal tract radiographic procedure			
%	57.2	11.9	3.6
OR	36.2	3.7	1.0
Rights and responsibilities section of Medicaid application			
%	81.1	31.0	7.3
OR	54.3	5.7	1.0
Standard informed consent document			
%	95.1	72.1	21.8
OR	70.5	9.4	1.0

Note. OR = odds ratio; TOFHLA = Test of Functional Health Literacy of Adults. Data are from "Inadequate Functional Health Literacy Among Patients at Two Public Hospitals," by M. V. Williams, R. M. Parker, D. W. Baker, N. S. Parikh, K. Pitkin, W. C. Coates, and J. R. Nurss, 1995, *Journal of the American Medical Association, 274*, Table 3, p. 1680. Copyright 1995 by the American Medical Association. Reprinted with permission.

Health literacy reflects mostly g. Health literacy researchers generally eschew any notion of intelligence for fear of inviting offensive distinctions onto the low-literate indigent and minority populations they study. There are several reasons, however, to believe that their measures are moderately to highly *g* loaded. First, the TOFHLA correlates highly with other tests of health literacy, such as the Wide Range Achievement Test—3 (.74; Parker et al., 1995), which in turn correlate moderately well with Full-Scale IQ (.53) and the Verbal Scale (.63) on the Wechsler Adult Intelligence Scale (WAIS; G. S. Wilkinson, 1993, p. 180).

Second, TOFHLA literacy behaves in key ways like functional literacy and work literacy, which clearly are mostly *g*. For instance, like both the latter, the TOFHLA samples a wide variety of tasks that adults are routinely expected to perform, and comprehension is not improved by presenting tasks in oral rather than written form. Third, health literacy researchers were just as surprised as NALS researchers to discover that literacy is very general. They, too, soon concluded that low literacy reflects "limited problem-solving abilities" and began describing literacy as the "ability to acquire new information and complete complex cognitive tasks" (D. W. Baker, Parker, Williams, & Clark, 1998, pp. 796–797).

A fourth sign that health literacy is largely *g* is seen in the strategies that health practitioners use to render health communications more comprehensible to low-literacy patients (Doak, Doak, & Root, 1996). Those strategies mirror the guidelines for simplifying written materials that were developed by Army researchers seeking to enhance the work literacy of low ability soldiers (Sticht, 1975). They constitute, in effect, a primer for reducing the complexity and information content of a communication. For example, omit all nonessential information; describe the specific behavior required of the individual; use simple vocabulary; require reading no higher than the fifth grade level; use simple line drawings (photographs contain distracting, irrelevant information); use several headings, arrows, or the like to summarize or draw attention to the most important pieces of information; and limit the number of type fonts and colors to minimize distraction. That is, provide no theory, require no inferences, provide only the bare minimum of information that must be understood to produce the desired behavior, and eliminate all else on the page that might distract rather than draw attention to it. Recall that degree of inference required, number of pieces of information used, and embeddedness in irrelevant and distracting material were all core elements of processing complexity in the NALS items.

As health literacy researchers point out, educational level is a fallible guide to any particular individual's literacy level because education through high school represents only years of exposure to learning, not actual accomplishment. Low-literacy populations tend to read at least four grade levels below the highest grade they have completed (usually Grade 10 or 11). The Army found exactly the same result: Its low-literate soldiers read four grade levels below the highest grade they had completed (10.7, on the average; Sticht et al., 1987, p. 45). NALS data also show that a quarter of young adults who left school with 9–12 years of education but no diploma read no better than the average fourth grader (Kirsch & Jungeblut, n.d., p. 40).

Health literacy affects health knowledge. Table 5 provides failure rates on sample TOFHLA items for patients classified as having inadequate, marginal, and adequate health literacy in a sample of clinic patients in two urban hospitals. Passing rates on even the simplest tasks tend to be low: 26% of the 2,659 patients did not understand information about when a next appointment was scheduled, 42% did not understand the directions for taking medicine on an empty stomach, and 60% did not understand a standard informed consent document (Williams et al., 1995). Relative risk of failing the TOFHLA items rose among the less literate groups, and the risk gradients were much steeper for the more complex tasks. ORs ranged from 6.0 to 70.5 for patients with inadequate literacy when compared with those with adequate literacy.

To be effective, treatment for chronic illnesses such as diabetes and hypertension requires considerable, life-long participation of the patient. Patients with these illnesses presumably receive instruction from their doctors and are motivated to learn how to help monitor, medicate, and otherwise control their illness. Yet patients with low literacy still have shockingly low rates of knowledge about the most basic symptoms of their disease—ones, moreover, that often require them to take immediate action. For example, among 114 diabetics taking insulin daily, fully half of those with inadequate literacy but only 6% of those with adequate literacy did not know that feeling sweaty, nervous, and shaky is usually a sign that their blood glucose level is low. About 62% versus 27%, respectively, did not know that if they suddenly feel that way, they should eat some form of sugar (Williams, Baker, Parker, & Nurss, 1998). This is not esoteric knowledge but is absolutely basic for insulin-dependent patients knowing how to control blood glucose level on a daily basis. Among 402 patients taking daily medicine for hypertension, there were comparably large differences between the two literacy levels in knowledge of which blood pressure levels are high and which are normal. Such knowledge is essential because patients with hypertension are often expected to monitor their own blood pressure to make sure that it remains within safe limits.

The ORs for patients with inadequate literacy not knowing these sorts of facts about their disease ranged from 2.0 to 15.9 for those with diabetes and from 2.4 to 9.0 for those with hypertension (Gottfredson, 2002, p. 366). These ORs represent somewhat lower levels of risk than those seen in Table 5 for more general sorts of health information, but they illustrate that low literacy remains a significant disadvantage even when people receive instruction in what they are presumably motivated to learn. These results seem consistent with job performance research: Training and experience help, but they do not neutralize the disadvantages of low *g*.

Health literacy predicts health outcomes, even after social class is controlled for. Being more literate does not guarantee better compliance or healthier behavior, but evidence links health literacy, so far, to hospitalization, number and severity of current illnesses, annual medical costs, and self-rated health. The first such study looked at the Sickness Impact Profiles (SIP) of low-level readers enrolled in basic education classes in Arizona (Weiss, Hart, McGee, & D'Estelle, 1992). Adults who read at Grade Levels 0–3 had SIP scores in the range found for persons with serious chronic illnesses. A second study calculated the average annual health costs of 400 randomly selected Medicaid participants (Weiss et al., 1994). Those with the lowest reading levels (Grades 0–2) had annual health care costs of $12,974 compared with $2,969 for the group as a whole. The least literate among the poor thus appeared to have more frequent or more severe health problems, but cost was clearly not a barrier to care (Weiss et al., 1994; see also Marwick, 1997, on the impact of low literacy on health care costs).

A third study prospectively followed 958 outpatients of an urban hospital for 2 years (D. W. Baker et al., 1998). Patients with inadequate TOFHLA literacy (35% of the sample) were twice as likely (31.5%) to be admitted to the hospital at least once during the 2 years as were patients with adequate literacy (14.9%). Their relative risk was 1.69 even after demographics, self-reported health, economic indicators, and health insurance coverage were controlled. Education had a weaker relation to hospitalization (adjusted OR of 1.27). Among patients who had been hospitalized in the year preceding the study, the relative risk of hospitalization during the 2 years for patients with inadequate literacy was yet higher (3.15).

Finally, a study of three urban hospital outpatient populations found that inadequate TOFHLA literacy was more strongly related to self-ratings of poor health (ORs of 1.89, 2.23, 2.55 in the three samples) than was education (ORs of 1.47, 1.53, and 2.13; D. W. Baker, Parker, Williams, Clark, & Nurss, 1997). Literacy appeared to be the active ingredient in education, because education no longer correlated with self-rated health after literacy was controlled. After age, gender, race, and socioeconomic markers were controlled, relative risk owing to low literacy was still in the moderately strong range—1.72, 2.19, and 2.12. Moreover, the relationship between literacy and self-reported poor health was not related to insurance status or self-reported difficulty in paying for medical care, getting time off from work, or obtaining child care (D. W. Baker et al., 1997, p. 1029).

Health self-management is inherently complex and thus puts a premium on the ability to learn, reason, and solve problems. As noted, health literacy researchers suggest that literacy is a highly general “learning ability”—an “ability to acquire new information and complete complex cognitive tasks”—and that “limited problem-solving abilities” make low-literacy patients “less likely to change behavior on the basis of new information” (D. W. Baker et al., 1998, pp. 796–797).

Patients cannot be passive recipients of medical recommendations with which they merely comply. Rather, many illnesses require the active participation of patients for proper diagnosis and treatment. We are our own primary providers of health care. This is especially true for chronic illnesses such as asthma, diabetes, and hypertension, because they require extensive self-regulation, which includes prevention, attack management, and social skills in maintaining social support (Clark & Starr-Schneidkraut, 1994). With asthma, for example, prevention entails “recognizing early signs of asthma, acting on early signs to ward off an attack, identifying and controlling triggers, and taking prescribed medicines properly and on schedule” (Clark & Starr-Schneidkraut, 1994, p. S54). “Patients with asthma must deduce when and how best to use medicines [for example, with peak flow monitoring], because drug use in asthma is not just a matter of adhering to an absolute formula the physician provides” (p. S55). There is no “sure-fire formula” for controlling symptoms, and patients must “exercise a high level of decision making in the absence of health professionals” (p. S56). Diabetes, another condition requiring close daily monitoring and adjustments in self-treatment, is even more demanding in this regard (Jovanovic-Peterson, Peterson, & Stone, 1999), especially for insulin-dependent patients and yet more so for ones using the new forms of tight control (Juliano, 1998). These chronic conditions are similar to jobs that require considerable knowledge for good performance, but, because conditions keep changing, the jobs cannot be routinized. Like such jobs, chronic diseases therefore require constant judgment in applying old knowledge and the need to spot and solve new problems. They require the daily exercise of *g.* Not just *g*, but always *g* to some extent.

Chronic lack of good judgment and effective reasoning leads to chronically poor self-management. As just noted, proper self-management of asthma involves regular, noncrisis visits to health care providers and taking action to prevent or moderate an asthma attack when one seems imminent. Patients who fail to do so often end up in the emergency department (ED). A study of 120 Canadian asthma patients (Hanania, David-Wang, Kesten, & Chapman, 1997) showed that patients who rely on the ED for their asthma care have less knowledge about asthma and how to manage it than do patients making unscheduled visits to the same hospital’s walk-in asthma clinic (AC). The ED patients were also less likely than the AC patients to have a predetermined crisis plan (23% vs. 79%). The discrepancy between the ED and AC groups was even greater for starting or increasing use of their steroids before seeking care (17% vs. 89%). ED patients also sought health care more often than did the AC patients, but that care was less often in the AC. Canada provides universal health care, so cost was not a factor in seeking ED rather than AC care. There were no differences in the availability of child care, difficulty of taking time off without loss of pay, or the intrinsic severity of their disease over the long term. The authors did not measure literacy but noted that the ED dependence was correlated with low income. They speculated, however, that low income is “a marker for suboptimal health care utilization rather than a cause of it” (p. 293).

The job of patient is becoming more complex and hence more g loaded. Policy analysts worry that people with poor basic skills will fall further behind in an increasingly complex economy (Berlin & Sum, 1988; Reich, 1992). Health scientists, too, worry about the increasing complexity of health care. The explosive growth in new treatments and technologies has created “tremendous learning demands” (D. W. Baker et al., 1998, p. 791) for anyone with a chronic disease. It therefore portends increasing relative risk for low-*g* patients. For example, with regard to the complex new treatment protocol for heart attacks, a “patient’s ability to learn this regimen and follow it correctly will determine a trajectory toward recovery or a downward path to recurrent myocardial infarction, disability, and death” (D. W. Baker et al., 1998, p. 791). As self-care increases in complexity, high-*g* patients will benefit more than others.

Studies of hypertension illustrate the difficulties that low-literacy individuals have in complying with complex new treatments. Rates of noncompliance are high in all groups because hypertension is usually without obvious outward symptoms. However, noncompliance is especially high in inner city populations, who, besides being underinsured, seem “to be disinclined to seek health care, and to be less capable of following a prescribed regimen than the populace as a whole” (Francis, 1991, p. 1A-29S). As a result, Francis (1991, p. 1A-29S) concluded that clinics serving those populations should choose a drug regimen, whenever possible, that requires no more than one dose a day and to avoid therapies that require multiple doses of multiple drugs.

However, simplifying treatment sufficiently to gain adherence from low-literate populations can lead to suboptimal therapeutic regimens. Such patient-driven simplification may explain the seeming failure of physicians to follow medical guidelines in some locales. For instance, a study in Philadelphia found that rates of prescriptions filled for suboptimal asthma drugs (bronchodilators) rather than the antiinflammatory drugs recommended for asthma (inhaled steroids, which do not produce an immediate response) were higher in zip code areas with lower average levels of education (Lang, Sherman, & Polansky, 1997). Education was the strongest demographic correlate of underprescription and underuse of recommended drugs (literacy was not measured). The authors suggested that a likely explanation for this pattern is that

> whereas people with higher socioeconomic status adopt healthy lifestyles more readily, people with lower educational attainment (lack of high school diploma) are less likely to exhibit proactive health maintenance behaviors for chronic relapsing conditions, such as asthma, and are more likely to respond poorly to health education efforts. (Lang et al., 1997, p. 1197)

Physicians who underprescribed the best drugs may have been trying "to achieve congruence with expectations of patients, who primarily seek relief from symptoms" (Lang et al., 1997, p. 1198) of bronchoconstriction. In other words, low literacy patients may drive a process of simplification that renders their treatment nonoptimal in order that they gain any benefit at all from it. This process, again, tilts the advantages of medical innovation toward more able patients.

"Today most illnesses are chronic diseases—slow-acting, long-term killers that can be treated but not cured" (Strauss, 1998, p. 108). They begin developing long before any symptoms appear, which puts a premium on foresight and prevention. Once diagnosed, responsibility for their day-to-day management falls primarily on the afflicted individuals themselves, with health professionals playing a secondary role. Health may therefore depend at least as heavily on quality of self-care as medical care, whatever the disease involved. The continued need to learn and solve problems in the career of patient indicates, in turn, that self-care depends heavily (but hardly only) on *g*.

Relation of *g* and Social Class to Accidental Injury and Death

Injuries from accidents rival chronic disease as a public health problem. *The Injury Fact Book* (S. P. Baker, O'Neill, Ginsburg, & Li, 1992, p. 20) reports that about one third of the population each year sustains an injury that requires medical treatment or results in at least 1 day of restricted activity. Injuries were the fourth leading cause of death in the United States in 1998, surpassed only by cancer, heart disease, and stroke (Steenland, Halperin, Hu, & Walker, 2003, p. 74). Moreover, injuries were the leading cause of death from ages 1–44 in 1986, accounting for about half of all deaths from ages 1–14 and 25–34 and over three quarters between ages 15–24 (S. P. Baker et al., 1992, pp. 8–9). Human behavior is important in preventing both accidents and chronic disease, so both are targets of massive public information campaigns. Such campaigns often lower morbidity and mortality rates, but not evenly across all sectors of society (Sobel, 1994).

Injuries are "caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance" (S. P. Baker et al., 1992, p. 4). Accidents represent unintentional injuries and thus exclude injuries from attempted suicide and homicide. Although most accidents represent sudden, acute assaults on physical well-being, whereas ill health is often chronic and slow developing, both often emerge after a slow buildup of hazards.

Accidents Are Not Random but Emerge From Patterns of Human Action and Inaction

Accidents are not visited on people randomly, nor are hazards evenly distributed to all occupations, ages, sexes, or locales. Most important here, the accident literature has clearly established that some individuals tend to have more accidents than others, even with the same level of exposure to the same hazards in the same environments (Boyle, 1980; Hale & Glendon, 1987, pp. 314–316). Methodological constraints have made it difficult to identify what the pertinent individual differences are. Accident research has established, however, that the risk of accidents is higher among workers who have less knowledge or only a few months' or years' experience (after which time their risk plateaus) and when tasks are more complex, novel, or confusing (Boyle, 1980, p. 54; Hale & Hale, 1972). Recall that the same pattern was found for overall job performance.

Buffardi, Fleishman, Morath, and McCarthy (2000) recently confirmed that errors increase when tasks demand higher cognitive abilities. They found that error rates—human error probabilities (HEPs)—on work tasks in Air Force and nuclear power plant jobs generally correlated .50 to .60 with the number and level of cognitive abilities that the tasks required. A large study by AT&T estimated that it could reduce employee accidents by 17% and absences due to illness by 14% if it hired from the top 40% of applicants on an aptitude test (McCormick, 2001). And, as noted earlier, the Australian Veterans Health Studies found that IQ was the best predictor of motor vehicle deaths among veterans by age 40. Compared with men who were somewhat above average in IQ (IQ 100–115), the MVA death rate for men of IQ 85–100 was twice as high (92.2 vs. 51.5 per 10,000), and for men of IQ 80–85 it was three times as high (146.7; O'Toole, 1990). (Like the United States, Australia does not induct anyone below about IQ 80 owing to low trainability.)

Accident Prevention and Control Is a Highly Cognitive Process

Hale and Glendon's (1987) theoretical synthesis of the accident literature shows that the real question is not what causes accidents but what prevents them. We are continually exposed to hazards of one sort or another and therefore must drive defensively through life to minimize harm. In fact, hazards are so common that "we should be surprised not by how often people fail to control danger, but by how frequently they succeed" (Hale & Glendon, 1987, p. 19). Safety is where "the system is under control and the harm process *has not begun*" (p. 13, emphasis added).

Like others, Hale and Glendon's (1987) accident model thus begins with a system under control. The health belief model in health research (Rosenstock, Strecher, & Becker, 1988) looks at much the same danger control process, because it examines how some people succumb to preventable illnesses by failing to seek timely health care, persisting in risky behavior, and the like (Hale & Glendon, 1987, pp. 126, 194). The accident model summarized in Table 6 shows, however, that it is useful to distinguish among seven stages in the development—and hence prevention—of illness and injury. As I show, recognizing and controlling danger is a quintessentially cognitive process.

Failure to prevent incidents. In systems under control (Stage 1), individuals necessarily pay only peripheral attention to safety most of the time, because their attention is concentrated on accomplishing the tasks at hand. However, a process that is under control (driving a car, mowing the lawn, or playing baseball) is seldom hazard free, so people must always be alert for signs that something is not right, or they might veer into danger. Likewise, just as responsible companies make regular safety inspections and urge their workers to observe safety precautions, prudent individuals take their cars for preventive maintenance and themselves for periodic physical exams and dental checkups. Many chronic diseases require daily self-regulation to keep body systems within safe limits (blood pressure for hypertension, blood glucose level for diabetes). Lax self-care, like inept or corner-cutting use of equipment, can precipitate emergencies. Systems remain under control only because people keep them under control as they go about their business.

The greater complexity, time pressure, or level of distraction is involved in performing a task, the more difficult it is to maintain focus, monitor deviations, and even know how to keep activities on course. Most industrial accidents happen, as noted earlier, while workers are performing tasks that are complex or nonroutine and thus require them to solve new problems and use less-exercised

Table 6
Victim Actions That Can Prevent or Precipitate the Development of Accidents

Accident stage	Action required	Some reasons victims fail to act as required[a]
System under control	Monitor in generalized manner Keep routine performances within normal limits Select appropriate approach to nonroutine tasks	Disruption, lapse of attention Situation not as expected Lack of knowledge/false beliefs Poor/decayed skills Poor understanding of system limits, needs, standards Alcohol, drugs, fatigue
System unstable	Detect abnormal deviations (i.e., warning signs) Search for the hazard Identify hazard Mitigate hazard	Attention divided, overloaded Deviations are transient, hidden, or increase gradually Danger is latent/contingent on other events Nonroutine or complex tasks Alcohol, drugs, fatigue Perseveres with familiar but wrong corrective action Expects others to remove the hazard Accepts—or pressured to accept—thin safety margin in trade for other gains Overestimates ability to control situation
Incident begins	Detect danger/imminent harm Actively search for cause Identify where/why control has broken down	Warnings not clear, conspicuous, or comprehensible Attention narrow or distracted Past alarms have often been false Situation changing rapidly Faulty cause–effect mental models, poor reasoning
Incident containment	Select/execute appropriate corrective action If none established, improvise one	Underestimates risk or urgency Perseveres with familiar but wrong corrective action Internal/external pressure for too-quick action Stress, confusion, mental overload Lacks knowledge, experience, reasoning ability Believes that lacks any effective control Believes others are responsible or in control Immobilized by vividness, dreadfulness, severity of potential harm
Damage begins	Detect harm Identify where/why damage is occurring	Ambiguity Situation changing rapidly Damage not visible, occurs slowly
Damage containment	Act to contain/limit damage Select appropriate procedure If none established, improvise one	Underestimates susceptibility to harm Underestimates degree of actual/potential harm Discounts future harm while overstating current benefits System or process is complex, fast changing Faulty cause–effect reasoning
System restored or modified	Rehabilitate victim Modify environment/behavior to reduce hazards, improve warnings, and limit future harm	Misdiagnoses cause, course, consequences of incident Underestimates damage and continuing danger System complex Discomfort, inconvenience, cost of change

Note. Based on Hale and Glendon's (1987) model of the danger control process.
[a] These are errors in light of information, equipment, and other resources that were available to the victim at the time.

skills (Hale & Glendon, 1987, Chapter 4; Saari, Tech, & Lahtela, 1981).

Most catastrophic accidents, such as the Piper Oil platform fire, Bhopal toxic chemical plant disaster, and Challenger and Chernobyl explosions, result from a gradual, unseen buildup—an incubation—of danger that may originate in hazards from multiple sources, such as other individuals' mistakes in designing facilities, maintaining equipment, monitoring industrial processes, and coordinating information (Paté-Cornell, 1993; Reason, 1990, Appendix). The same gradual buildup of danger typifies chronic disease. Accordingly, there is seldom an unambiguous demarcation between systems under control (Stage 1) and going out of control (Stage 2).

Detecting early warning signs has been a special focus of the accident literature, but it is also key in preventing health emergencies.

> The ability to read signs that portend a crisis is the first important step in managing chronic illness. . . . When signs aren't properly read, are read too slowly or are interpreted as meaning something else, then people die or come close to dying. . . . The complexity of the human body can cause even experienced persons to misread important signs. (Strauss, 1998, p. 109)

Detection is especially difficult when deviations develop slowly and unobtrusively and, of course, when attention and judgment are impaired (e.g., drugs, alcohol, cognitive overload). Hale and Glendon (1987) stressed that once something abnormal is detected (an unusual vibration in equipment, chest pain), incident prevention requires an active consideration of what the deviation means and then taking effective action.

Hale and Glendon (1987) pointed to a study of 405 accidents in South African gold mines, involving 794 errors by 575 people, to illustrate that accident victims have often failed to detect, diagnose, and react to visible, imminent danger:

> In all but three incidents there was some indication of the approaching danger. Nearly 50% of the people involved failed to perceive the warnings, such as they were, and so made no attempt to avoid the danger (often a rock fall). Of the 290 who perceived the warning, 257 (89%) recognized it as such, but only 57 (22%) of them correctly estimated the risk. One hundred forty of the 257 (54%) made no response to the warning, 40 (16%) responded appropriately (by warning others), and the remaining 77 (30%) made an ineffective response. (pp. 42–43)

Pedestrian accidents in U.S. cities have shown the same general pattern, in that most of the pedestrians and drivers involved failed to search for, detect, properly evaluate, or respond appropriately to existing signs of danger (Hale & Glendon, 1987, p. 43). Recall, also, that the same populations who know least about the warning signs of cancer and other serious illness also underuse (even free) preventive health services (e.g., mammography) that might reveal an incubating problem.

The gold-mining example illustrates that, just as there is seldom a bright line between systems being stable (Stage 1) and unstable (Stage 2), there is seldom a bright line between instability (Stage 2) and the beginning of an incident (Stage 3). Once an incident has begun (two vehicles on a collision course, furniture smoldering, sharp chest pains, blood glucose much too high or low), there generally are options for limiting its scale and averting damage (Stage 4). If conditions are deteriorating rapidly, however, it may not be at all clear what to do, especially if the incident is not among those for which the person or organization has contingency plans—or should have had a plan (recall the asthma patients whose failure to plan for asthma attacks landed them more often in the emergency room). Quick problem solving becomes crucial. One may even need to suppress natural responses that would only increase the danger—such as braking suddenly when a car slides on ice or throwing water on a grease fire in the kitchen. Here, prior knowledge is crucial.

As was clear in the gold-mining study, many people also do too little too late to limit the escalation of an incident (worsening fever, infection, fire, tumor) or their involvement in it (not leave the site of a gas leak or imminent hurricane in a timely manner) because they either underestimate the risk or overestimate their ability to control the situation. Others take no action at all because they believe either that they lack any effective control (losing weight) or that someone else (a supervisor or coworker) has control.

Failure to contain damage. If allowed to progress too far, accidents and illness can begin to cause injury (Stage 5). With accidents, the incident and the injury often coincide, but this is not so with illness. Poorly managed hypertension may lead only later to a stroke and then to a series of strokes, heart disease to one or more myocardial infarctions, diabetes to amputations and blindness. When accidents cause their damage over a period of time, there is opportunity to limit the scope or severity of damage (Stage 6). Quick transit to a hospital, new techniques in burn or cardiac care, firewalls in buildings, emergency cut-off valves, and other external factors can contain the damage caused by accidents and health emergencies.

But cognitive competence also matters. Underestimating risk, overestimating control, and not understanding how damage is caused can result in a failure either to take prior precautions for minimizing damage (wearing seat belts, helmets, protective clothing) or to take timely action to contain damage once it has begun (evacuating a burning facility, stopping a runaway reaction in a nuclear power plant, seeking timely diagnosis of potentially cancerous growths). Lack of prior knowledge about containing damage may also let it mount needlessly—knowledge such as stop, drop, and roll, apply a tourniquet for severe bleeding, get a tetanus shot for dirty puncture wounds, and do not move people with possible back injuries.

Once an accident or illness is under control and the damage process is halted, prudence requires a review of what happened and how reoccurrence might be prevented (Stage 7). In industry, this may mean redesigning facilities and equipment, retraining workers, having them wear better protective gear, developing additional contingency plans for emergencies, and so on. For personal health, it often means changing one's lifestyle. But permanently changing safety behavior is notoriously difficult (S. P. Baker et al., 1992, p. 233, on seat belt use; Kjelsberg, 1982). Patients and workers alike will forgo some safety and health precautions when they believe those precautions to be uncomfortable, inconvenient, unattractive, or embarrassing (Davis, Arnold, et al., 1996, on mammograms; Hale & Glendon, 1987, pp. 354–355; Hale & Hale, 1972, pp. 74–75, on safety goggles, ear protectors, etc.). Getting people to change bad health habits is all the more difficult when the causal link between current habits and future health is uncertain and abstract and when backsliding produces no discernible consequences in the short run.

Recall that Arvey's (1986) dominant Judgment and Reasoning factor among job demands correlated most highly with the ability to "deal with unexpected situations" (.75), "learn and recall job-related information" (.71), "reason and make judgments" (.69), "identify problem situations quickly" (.69), "react swiftly when unexpected problems occur" (.67), and "apply common sense to solve problems" (.66) (Arvey, 1986, Table 1, p. 418). These are precisely the skills that the accident prevention process calls on most. Moreover, we also saw that accidents occur more frequently in situations that tax these abilities most heavily—complex, nonroutine, and ambiguous. Once again, general mental competence is hardly the only thing that matters in the accident process, but it always matters. It thus relentlessly tilts the odds against the less cognitively able.

SES-Related Relative Risk of Accidental Death Is General but Patterned by Accident Type

Neither environmental nor genetic hazards are evenly distributed among us, but we all have considerable control over whether we succumb to the hazards to which we are involuntarily subject. Moreover, we often knowingly expose ourselves to hazards, whether for pleasure, profit, or mere convenience. For example, we choose to smoke, get drunk often, drive too fast, sunbathe, swim alone or in unsafe waters, smoke in bed, walk on train tracks, dart on foot across busy thoroughfares, play with firearms, and not wear our seat belts. We also expose other people to hazards, whether by commission (driving recklessly, leaving young children home alone or locked in hot cars) or by omission (failing to install a smoke alarm in our home, failing to supervise young children or to keep matches, guns, and poisons locked away from them).

The more personal choice we have in conducting our life as we see fit, the more our fate depends on our own knowledge, judgment, and foresight—and, hence, on *g*. All forms of accident are amenable to some control, even if limited, and therefore—like jobs—they all call for some exercise of *g*, which, even if minor, can cumulate over time. Degree of personal control is likely to differ greatly, however, from one type of accident to another, which suggests that *g*-related relative risk (and, hence, SES-related relative risk) should be steeper for some types than others. Conversely, when some types of accidents have steeper *g*- or SES-related risk gradients than others, this indicates that their most basic causal factors differ.

The data for nonfatal accidents are somewhat spotty in both quantity and quality, but there are fairly good data on fatal accidents because all deaths must be recorded. The mortality data nonetheless must be interpreted with caution, because accidental deaths are just the tip of the accident iceberg and because whether injuries eventuate in death depends not only on the severity of injuries but also the success with which they were treated (Stage 6). In addition, any particular mortality rate may reflect a composite of distinctly different populations of injuries.

Generality of SES-related relative risk. Table 7 shows death rates per 100,000 population in the United States for 69 different categories of injury published in the latest edition of *The Injury Fact Book* (S. P. Baker et al., 1992). The table also provides relative risk (ORs) according to per capita income of victim's area of residence. Looking first at the overall rate of injury deaths, which include intentional ones, too (homicide and suicide), we see the familiar social class gradient: Relative risk is seven times higher for the lowest than the highest of six neighborhood income levels (ORs of 3.5 vs. 0.5).

There is no clear SES–death gradient, however, for either murder or suicide (respectively, 14% and 21% of fatal injuries in 1986; S. P. Baker et al., 1992, p. 18; but see contrary data for employed adults classified by occupation in Steenland et al., 2003). A clear income–mortality gradient is found only for unintentional injuries, and it is essentially the same for vehicle-related as for nonvehicle-related ("other unintentional") deaths: The ORs range, respectively, from 2.1 and 2.0 in the lowest income neighborhoods to 0.7 and 0.8 in the highest. There is thus something about the people or their circumstances in low income neighborhoods that puts residents at higher risk of accidental but not intended deaths.

Of the 29 categories of unintentional death listed in Table 7, only one shows higher mortality at higher income levels (aircraft accidents, most of which involve personal planes), and the difference is only slight. Another four or five exhibit no clear social class gradient (falls, motorcycle and bicycle deaths, unintentional poisoning with solids or liquids, pedestrian–train accidents, and perhaps suffocation). For all the remainder—from choking on food, drowning, and dying in car crashes to accidental death by firearms, explosions, falling objects, natural disasters, and neglect—residence in lower income areas is associated with higher risk, and risk usually rises in a fairly regular manner down the income gradient. This breadth and monotonicity of the SES–accident relation replicates the generality of the SES–health relation for chronic disease.

Patterns of SES-related relative risk. Table 7 shows that the SES-related risk gradients often vary considerably for different causes of accidental death. Of the 24 specific forms where risk of death rises as neighborhood income falls, 7 have ORs (for the lowest income areas) between 1.3 and 1.9, 11 between 2.0 and 4.0, and 6 between 4.1 and 7.4.

The first subset of causes listed in Table 7 disproportionately affects the very young and very old. These age groups are not only the most physically vulnerable but also the least mentally adept, making them the most dependent on the competence and foresight of caregivers. (Fluid *g*—raw mental horsepower—falls as much between ages 18–80, on the average, as it rises between ages 8–18; Salthouse, 2000.) Focusing on relative risk for people from the lowest income neighborhoods, we see that there is no income–mortality gradient for falls (1.0), a shallow one for suffocation and pedestrian traffic deaths (both 1.3), and somewhat steeper ones for choking (1.5) and colliding with objects (1.8). Risk gradients for these forms of death may be steeper partly because of the inability of victims and the persons near them to anticipate and deal effectively with what are generally only minor mishaps for ages that are more physically capable on the average. Such inability would allow the incidents (e.g., choking) to progress largely unimpeded toward eventual death.

The risk gradient is steeper—and moderately strong—for fire/burn deaths, because ORs range from 2.5 to 0.6 going up the income continuum. Mortality from fires (mostly smoke and fumes) and burns (including scalds) is heavily influenced by the physical ability of people to escape in a timely manner or to survive any

Table 7

Rates of Death From Injury per 100,000 Population and Relative Risk (OR) by Per Capita Income of Area of Residence, 69 Causes,[a] 1980–1986

Variable	Deaths per 100,000	Per capita income (in thousands)					
		<$6	$6–$7	$8–$9	$10–$11	$12–$13	$14+
69. Total (Causes 1–68)	64.04	3.5	2.5	1.1	1.0	0.7	0.5
Intentional injuries							
58. Suicide (50–57)	12.24	0.9	1.0	1.0	1.0	1.0	0.8
64. Homicide (59–63)[b]	9.15	0.9	0.9	0.7	1.0	0.5	0.3
Unintentional injuries							
6. Motor vehicle accidents, traffic (1–5)	19.96	2.1	1.7	1.3	1.0	0.9	0.7
48. Other unintentional (7–47)	21.20	2.0	1.7	1.1	1.0	0.9	0.8
Primarily the very young and old							
27. Falls (21–26) (elderly)	5.21	1.0	1.4	1.1	1.0	1.1	0.9
40. Suffocation (infants)	0.38	1.3	1.5	1.1	1.0	1.1	0.8
5. Pedestrian, traffic (elderly)	3.19	1.3	1.1	0.9	1.0	0.8	0.6
38. Aspiration, food (infants, elderly)	0.78	1.5	1.5	1.2	1.0	1.0	0.9
42. Collision with object/person (very old)	0.11	1.8	1.9	1.3	1.0	1.0	0.8
39. Aspiration, nonfood (infants, elderly)	0.68	2.1	1.8	1.3	1.0	1.0	0.9
31. Fires/burns (28–30) (1–4 years and elderly)	2.30	2.5	1.9	1.2	1.0	0.7	0.6
7. Pedestrian, nontraffic (1–4 years, e.g., driveways)	0.20	2.7	1.9	1.3	1.0	0.9	0.6
34. Excessive cold (infants, elderly)	0.34	3.1	2.2	1.3	1.0	0.7	0.6
33. Excessive heat (infants, elderly)	0.22	4.4	2.5	1.8	1.0	0.6	0.6
35. Exposure/neglect (infants, elderly)	0.12	7.4	3.3	1.8	1.0	1.2	0.8
Primarily young men							
3. Motorcyclists, traffic	1.51	0.7	0.8	0.9	1.0	0.9	0.5
4. Bicyclists, traffic	0.36	0.9	1.0	1.1	1.0	0.9	0.6
12. Drowning (10–11)	2.60	2.0	1.5	1.1	1.0	0.8	0.6
2. Motor vehicle, occupant	14.88	2.4	2.0	1.4	1.0	0.9	0.7
1. Motor vehicle, train	0.26	3.2	2.8	2.2	1.0	0.9	0.6
36. Lightning	0.04	3.4	1.7	1.3	1.0	0.7	0.7
32. Firearm	0.73	4.4	2.6	1.3	1.0	0.6	0.6
Primarily adult men							
9. Aircraft	0.60	0.9	1.1	1.0	1.0	1.3	1.2
18. Poisoning, solids/liquids[c]	1.57	0.6	0.6	0.6	1.0	1.0	0.7
20. Poisoning, gas/vapor[d]	0.50	1.3	1.3	1.1	1.0	0.7	0.9
8. Pedestrian, train	0.18	1.4	1.4	0.8	1.0	1.0	1.2
43. Caught/crushed	0.05	1.5	1.7	1.2	1.0	0.7	1.0
45. Cutting/piercing	0.05	2.0	1.8	1.0	1.0	0.6	0.6
47. Electric current	0.40	2.1	1.8	1.4	1.0	0.8	0.5
46. Explosion	0.12	2.9	1.8	1.2	1.0	0.6	0.6
41. Struck by falling object	0.42	4.6	3.0	1.5	1.0	0.7	1.3
44. Machinery	0.57	5.0	4.1	2.0	1.0	0.8	0.5
Risk rises gradually with age, both sexes							
37. Natural disaster	0.06	5.0	2.7	1.2	1.0	0.5	1.0

Note. Numbered causes are listed in ascending order of OR for the <$6,000 income group. Calculated from data in Baker, O'Neill, Ginsburg, and Li (1992, Table 8, pp. 298–299, 312–313). OR = odds ratio.
[a] Some of the 69 are subtotals of others. [b] Four homicide categories are excluded here: homicide due to legal intervention with firearm (65), undetermined firearm (66), undetermined poisoning (67), and total undetermined (68). [c] Solid–liquid poisonings include opiates (13), barbiturates (14), tranquilizers (15), antidepressants (16), and alcohol (17). [d] Gas/vapor poisonings include but are not limited to motor vehicle exhaust (19).

serious burns. Small children and the elderly are at special risk in both regards. Fires are seldom just accidental, however. Cigarettes are the most common cause (28%), and children playing with matches account for another 10% (S. P. Baker et al., 1992, pp. 162–163). Half of adult fatalities in house fires show evidence of high levels of blood alcohol (S. P. Baker et al., 1992, p. 164). None of these kinds of error seems to relate to economic status per se. The burn deaths from children playing with matches, like the serious problem of gasoline burns among young boys (S. P. Baker et al., 1992, p. 170) and the nontraffic pedestrian deaths among 1-year olds (e.g., killed in private driveways; S. P. Baker et al., 1992, pp. 46, 272), also bespeak inadequate supervision. Fires started by heating equipment may relate to quality of housing (rather than, e.g., maintenance or proper use) and are, in fact, more common in poorer than richer neighborhoods, but they account for only 15% of fires (S. P. Baker et al., 1992, p. 163).

Relative risk becomes yet steeper for excessive cold (3.1 for people from the lowest income neighborhoods), excessive heat (4.4), and especially exposure/neglect (7.4), where the rates are especially high for persons aged 85 and older (not shown). In all three cases, damage presumably mounts for hours or days before causing death. Poorer housing might conceivably account for much of the excessive exposure of the poorest elderly, who may often live alone, but risk is also somewhat elevated among infants, who would never be living alone. Moreover, the SES gradient is especially steep when exposure/neglect is specified as the cause, which directly implicates faulty care. When these forms of accidental death occur among the other, more physically capable age groups, they may often be related to alcohol abuse, which is higher in the lower classes.

Mortality rates for the next set of accidents are all very much higher among young men, generally between ages 15 and 25, and reflect their high propensity for risk taking. Rates of motorcycle and bicycle deaths are slightly higher in the middle classes, but the other five causes show the usual negative relation with social class. Relative risk of death by drowning or motor vehicle accident is moderately strong (respectively, 2.0 and 2.4) for the lowest income group but higher for lightning (3.4) and accidental firearm deaths (4.4). It is not clear why risk of lightning deaths should rise so markedly as neighborhood income falls, though less knowledge of safety practices during lightning storms could be involved. People in the poorest neighborhoods are no more likely to be murdered (whether by firearms or not) than those in middle-income areas, but they are four times as likely to die from accidents with firearms. Differences in judgment, foresight, and knowledge of gun safety, perhaps compounded by alcohol abuse, may help account for this strong SES-related mortality gradient.

By far the largest number of fatalities in this young male set is from MVAs, where relative risk is 2.4 for the lowest income group. Differences in seat belt use (and, hence, the likelihood of surviving a crash) may be a factor, because one study found that adult drivers from high-income areas used seat belts at three times the rate of those in low-income areas and that the discrepancy was even greater among teenage drivers (S. P. Baker et al., 1992, p. 223). Alcohol abuse and other risky behaviors may also be factors, because one third of all fatal crashes occur between 6:00 PM and 5:59 AM on Friday and Saturday nights and about 80% of men aged 20–55 killed in nighttime crashes have blood alcohol concentrations of at least 0.10 percent (S. P. Baker et al., 1992, pp. 244, 254). (A third of adult drownings also involve excessive alcohol; U.S. Department of Health, Education, and Welfare, 1979, p. 9–26.) Lower intelligence may lead young men to take more such risks because, as noted earlier, IQ was the best predictor of motor vehicle fatalities among Australian veterans in their 20s and 30s.

The next large set of unintentional deaths affects primarily adult men. It includes the only form of accidental death that is positively associated with income (aircraft deaths), plus one other that is unrelated to social class (unintentional poisoning from liquids and solids, e.g., opiates, barbiturates, antidepressants, and alcohol). Gradients for the remaining eight range from shallow (OR of 1.3 for gas/vapor poisoning) to steep (5.0 for machinery accidents). The six with the steepest risk gradients represent common forms of job-related accidents and hence are the sorts of accidents—explosions, cuts, electrocution, falling objects, and getting caught in machines—that (together with fires and auto, train, bus, and plane accidents) have been most studied in the accident literature. Table 6 captures the cognitive processes known to be involved in such accidents, and the gold-mining example shows how cognition often fails, so the cognitive processes involved in this group of fatalities need no further elaboration. It is important to point out, however, that occupational exposure cannot fully account for the SES differences in relative risk because five of the six fatalities (excluding machinery deaths) occur as often from accidents at home as on the job (S. P. Baker et al., 1992, pp. 54, 114–133). Risk of such deaths seems cross-situational and therefore likely to inhere more in the individuals involved than in their situations.

The last cause of accidental death—natural disasters—is patterned very differently than all the others because relative risk of such mortality differs little by sex and rises only gradually with age (data not shown). Its SES gradient is among the steepest (from 5.0 to 0.5 across the income distribution), although it reverses somewhat at the highest income level (1.0). S. P. Baker et al. (1992, p. 41) speculated that exposure to natural disasters is fairly even by age and sex but that older individuals have greater difficulty escaping and surviving any injury, especially if there is delay in treatment. One could speculate that the strong income–mortality gradient for natural disasters results from poorer individuals possibly living in more vulnerable locales (flood plains) and homes (mobile homes, buildings less able to withstand earthquakes), but it may also result from their having more difficulty estimating degree of risk, the amount of control they retain, and therefore how quickly they should evacuate when there is advance warning.

In summary, income–mortality gradients for accidental injury replicate the generality of the SES-related risk gradients for health knowledge, health habits, and chronic disease. SES-related disadvantage in risk is also monotonic for most categories of fatal injury, thus reproducing the same mystery of the SES–health gradient, and—once again—despite big differences in kind, etiology, and age groups most affected. The danger control model suggests that the "something about life in the lower social classes that increases vulnerability . . . in general" (Syme & Berkman, 1976, p. 5) may include class disparities in *g* among individuals and their close associates. The danger control model also illustrates how many small errors and lost opportunities can add up to a few big consequences, whatever the life arena involved.

Well-Being in a Society That Offers More Choice and Complexity

Advances in sanitation, medicine, ergonomics, health science, and much more have greatly reduced morbidity and mortality as well as increased options for how we live our life in developed nations. Even the poorest stratum of Americans has access to material goods and medical care that far exceeds what most people in the world today could ever hope for. But with each technological advance, some sectors of society benefit more than others. Triumph over the scourges of infectious disease and dire poverty has not equalized physical well-being. Technological and social advance greatly increase both the complexity of our life and the choices we have. Although we welcome more choice, both choice and complexity put a big premium on *g*. If we knew more about life's daily demands for continual learning, spotting of problems, and reasoning, especially in health self-care, we might know better how to structure environments, deliver services, and provide instruction. This might ease the burdens of complexity and promote wiser choices for everyone, but especially persons lower on the IQ continuum.

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