

## IQ Gains Over Time: Toward Finding the Causes

James R. Flynn

This chapter describes the magnitude, pattern, duration, and prevalence of IQ gains over time. Its ultimate purpose is to suggest and evaluate research strategies that might generate promising causal hypotheses. However, the phenomenon to be explained dictates the task of explanatory hypotheses, which poses a fundamental question: Granted that people are better at taking IQ tests, what other, related cognitive skills are they better at? Estimates of the size of this package might range all the way from doing better at IQ tests plus some related cognitive skills too trivial to have significant real-world effects, to doing better on IQ tests plus all of the cognitive skills that are usually enhanced when one goes from a student with an IQ of 75 to a student at the next desk with an IQ of 100 or 125. My purposes dictate covering the following topics: describing and evidencing the brute phenomenon of IQ gains over time, discussing what other cognitive skills have escalated in tandem, using that discussion to critique the attempts at causal explanation made thus far, and suggesting research strategies that might engender better hypotheses. In addition, I discuss theoretical and practical implications of IQ gains when these issues seem significant enough to justify a digression.



## IQ GAINS OVER TIME

Data now are available for 20 nations, and there is not a single exception to the finding of massive IQ gains over time. These countries include the most advanced nations of continental Europe, that is, The Netherlands, Belgium, France, Norway, Sweden, Denmark, the former East and West Germany, Austria, and Switzerland. They include virtually all English-speaking nations, that is, Britain including Scotland, Northern Ireland, Canada, the United States, Australia, and New Zealand. They include two nations outside Europe but predominantly of European culture, namely, Israel and urban Brazil. They include two Asian nations that have adopted European technology, namely, Japan and urban China. The first pattern revealed is a correspondence between IQ gains and industrialization. Recent data show that IQ gains in Britain began no later than the last decade of the 19th century at a time when, paradoxically, IQ tests did not exist (see pp. 33-34). The time between the advent of industrialization and the beginning of IQ gains is probably short, and the two events may well coincide (Flynn, 1987a, 1994; Raven, & Court, 1993).

Recent IQ gains, those covering the last 60 years, are largest on tests that are supposed to be the purest measures of intelligence, tests of fluid intelligence (or fluid *g*) that are also culture reduced. The best example is the Raven Progressive Matrices, in which one identifies the missing parts of patterns that are presumed to be easily assimilated by people across a wide variety of cultures. It tests fluid intelligence because it measures the mind's ability to solve problems at the moment, which is distinguished from crystallized intelligence (or crystallized *g*). The latter represents the kind of knowledge an acute mind normally tends to acquire over time and is measured by tests like the Vocabulary, General Information, and Arithmetic subtests of the Wechsler verbal scale.

Raven data, and data for other tests as well, may be categorized as strong, fair, or weak. Strong data have come from military testing of comprehensive and nationwide samples of young adults or similar samples (comprehensive or random) of schoolchildren. Fair data have come from excellent local samples or nationwide samples of the quality of U.S. Wechsler standardization samples. Weak data have come from sam-

ples that fall short of U.S. Wechsler quality. Military data on the Raven, or matrices tests derived from the Raven, for The Netherlands, Belgium, Israel, and Norway are particularly valuable, not only for sample quality but also for the maturity of the subjects. All nations but Norway have shown gains at a rate of about 20 IQ points per generation (30 years). Norway was similar until 1968, but between that date and 1980, the gains ran at a generational rate of only 7.5 points. Raven data of only fair quality put British adults at 16 points (British children show much lower rates), Canada at 12 points, and Australia at 10. Strong data show that Sweden and Denmark have gained at a generational rate of about 10 points. However, although the tests measured fluid intelligence, none of the Swedish subtests and only one (of four) Danish subtests were matrices type or culture reduced. In 1985, Sweden may have become the first nation to register losses on a test of spatial visualization. It appears that gains in Scandinavia have been lower than in the low countries and Israel, but the fact that the tests differed is a confounding variable. Weak data mainly from the Raven have shown wide-ranging results for another six nations (Emanuelsson, Reuterberg, & Svensson, 1993; Emanuelsson & Svensson, 1990; Flynn, 1987a; J. Goldenberg, personal communication, March 4, 1991; Raven, et al., 1993, Graph G2; Teasdale & Owen, 1989).

Performance scale gains from Wechsler samples of schoolchildren have been similar to the results from tests of fluid intelligence. Only weak samples have shown gains above 20 points over a generation or below 9 points. However, there are two reasons for caution. First, the gains of White American children are the best evidenced, and they are at the lower end of this range at a generational rate of about 10 points from 1948 to 1972, perhaps a bit higher for 1972 to 1995. Second, tests like the Raven have generated much adult data, the Wechsler tests, very little. There is no obvious tendency for gains to diminish with age, but recent data from a small sample show that Japan might be an exception. Japanese schoolchildren have doubled the rate of gain of White American children, whereas Japanese and U.S. adults show similar rates (Flynn, 1987a, pp. 185-186; K. Hattori, personal communication, November 30, 1991; Wechsler, 1992, p. 198).



Verbal IQ gains vary from almost nil to 20 points per generation, with 9 as a rough median, and some of the evidence comes from adult data from military testing. Among the 11 countries that allow a comparison, there is not one in which verbal gains match the gains on Raven's type, performance, or nonverbal tests. Often the ratios run against verbal gains by two or three to one. Vocabulary gains have been similar to verbal gains in West Germany and Vienna, but they are lower in English-speaking countries, particularly in Northern Ireland and Scotland, where they are nil. British adults of all ages gained 27 points over 50 years on Raven's but gained only 6 points over 45 years on the Mill Hill Vocabulary Scale. Wechsler subtest data show negligible gains for general information and losses for arithmetic reasoning (Flynn, 1984b, p. 46, 1987a, pp. 185-186, 1990, p. 47; Lynn, 1990, p. 139; Raven, & Court, 1994, Table MHV3; Raven et al., 1993, Graphs G2, G6; Schallberger, 1987, p. 9; Schubert & Berlach, 1982, p. 262; Wechsler, 1992, p. 198).

### IQ AND OTHER COGNITIVE SKILLS

I want to contrast the significance of IQ differences between people who belong to the same generation with the significance of IQ differences between people who belong to different generations, that is, generations separated by time. Take three schoolchildren seated in a row with IQs of 75, 100, and 125. As one goes from one student to another, one would expect a certain escalation of associated cognitive skills. As IQ rose, one would expect the child to be better at arithmetic reasoning, as distinct from the mere mechanics of calculations, and to have a larger nonspecialized vocabulary and fund of general information. If within the school, one found a gifted class with a mean IQ of 125, one would expect them to learn more quickly and be more original and one would predict that in adulthood they would be inventive and make original contributions to their society. If one found a special-needs class with a mean IQ of 75, one would expect them to show a more limited participation in everyday life.

For example, Arthur Jensen related an interview with a young

man with a Wechsler IQ of 75. Despite the fact that this man volunteered baseball as his chief interest and attended or viewed games frequently, he was vague about the rules, did not know how many players composed a team, could not name the teams his home team played, and could not name any of the most famous players. Jensen later put the same questions to someone with a high IQ, a learned colleague who disdained the sport and had never attended a baseball game in his life. He answered them all and was puzzled as to how he knew so much about something he enjoyed so little (Jensen, 1981, p. 65).

Reverting to the three schoolchildren, if the child with an IQ of 100 were the first in the school to get a home computer or happened to belong to a chess club, he or she would be likely to have certain advantages over the child with an IQ of 125. For example, she might know how to word process, or have committed the rules of chess to memory, or know something about openings and endgames. However, that would not engender doubts about their comparative IQs because no matter what theory of intelligence one holds, one distinguishes among learning, memory, and intelligence. In my youth, the Irish, Italian, and Polish children who attended Catholic schools took more science and math, at least in the Southern and mid-Atlantic states, than children in public (or state) schools. Therefore, Catholic children demonstrated a higher competence in these subjects. But that would not lead one to expect them to have a higher mean IQ; if it did, one would be mistaken, as Thomas Sowell's data show (Flynn, 1991, p. 30).

I do not mean to imply that distinguishing intelligence from learning is always easy in practice. Richard Lynn (1987) argued that a substantial part of recent IQ gains over time really do represent intelligence gains, roughly a gain of a full standard deviation over 50 years. As evidence, he cited the enormous increase in scientific output between the current generation and the last, plus the great increase in the number of schoolchildren passing secondary school exams and going on to universities.

I remain unconvinced, for one thing, that the argument proves



too much for its own credibility. Just as there are more scientists living today than in all previous history and more students at higher levels, that has been true for every generation since the industrial revolution. If this sort of data evidence a standard deviation of intelligence gain every 50 years, there must have been two or three such gains in recent history, which simply does not seem plausible. More to the point, using the fact that the present generation has more scientists than the last generation to evidence enhanced intelligence rests on a false analogy with other types of group differences. When Chinese Americans produce more doctors than White Americans, there is at least a *prima facie* case that intelligence is a factor but only because both groups are competing for a limited number of places in medical schools at the same place at the same time. The progress of science does not show one generation *competing* more successfully than the last, but one generation *building* on the achievements of the last. It no more signals a group intelligence advance than do other generational differences that represent cumulative trends, such as increased numbers of accountants from one generation to another or of cordon bleu cooks.

Ken Vincent believes that the complexity of the modern world both causes and proves massive intelligence gains. He has said that people in industrialized countries live in a world with daily stimuli "beyond the wildest dreams of their grandparents" and that "our grandparents, because of a lack of environmental stimulation, were simply not bright enough as a group to have run the modern world" (Vincent, 1993, p. 62). He was careful to note that he does not deny that the current generation's grandparents had the potential to run the modern world, if only they had enjoyed the necessary environmental advantages.

No doubt these grandparents raised without video recorders, word processors, and computer games would (and do) find it difficult to cope if plunged into the modern world. Do we call this new ability our generation has developed "enhanced intelligence" or "acquired learning"? I have developed my mind by focusing on something far more complex than the modern world, namely, Plato's later dialogues. Those

who have done this cope with something that the philosophically naive would find daunting without decades of study, no matter what generation they belong to. Does that mean I am more intelligent than a nonphilosopher with the potential to understand Plato or that I am more learned? If I am merely more learned, why call the present generation more intelligent than the last?

This argument may not be fair to Vincent's point. Consider an analogy from sports: When athletes train to be pole vaulters, they do not just learn skills about manipulating the pole; they also develop new musculature, that is, alter their bodies in a way that confers an ability the untrained lack. The modern world has not only taught us how to "finger" modern contrivances, it has also altered our minds in a way that confers an ability to cope with such contrivances, an ability previous generations lacked. Does one call this new ability an addition to "crystallized intelligence" or a new "achievement"? Is the label arbitrary, just so long as one is clear about what has happened? If so, one would be free to choose either label on rational grounds and might argue that morality should guide the choice. Few would want to label Australian Aborigines "dumb" simply because they have been conditioned to cope with the Australian outback rather than the modern world.

I think it is counterproductive to become obsessed with labels like *intelligence*, *learning*, and *achievement*. The dominant theme is far more important: What package of enhanced cognitive skills does it make sense to bundle up with IQ gains over time, preparatory to seeking causal explanations? Here there is some unfinished business: Have IQ gains over time been accompanied by enhanced ability to participate in everyday life? To assess this, one needs some everyday activity shared by both the present world and the world of previous generations. Jensen has already provided readers with something. Within the present generation, take people with IQs below 75 when scored against today's norms: They often have difficulty coping with the complex rules of sports like baseball. What of previous generations, would those with IQs below 75 when scored against today's norms have had similar problems? I call this facet of intelligence, ideally





suitied to bridge distance between generations, "understanding-baseball intelligence."<sup>1</sup>

To progress, one needs an estimate of what proportion of some previous generation would have low IQs against current norms; this brings me to the British Raven data. In 1942, J. C. Raven administered the first standardization of the Raven Progressive Matrices. For ages 20 to 30, he selected soldiers in army camps whose education matched that of the total population of British men of similar age. For older ages, he tested large samples from a private firm and from a government department in which the majority of employees joined as youths and remained until retirement. They gave him a curve of performance from one age cohort to another, and he grafted that curve onto his military sample, thereby deriving norms covering all ages (Foulds & Raven, 1948; J. C. Raven, 1941). In 1992, Raven's son John restandardized Raven's on a representative sample of the adult population of Dumfries in Scotland, selected as typical of an area whose norms matched those of Britain as a whole (J. Raven, 1981, p. RS1.25). John Raven then took the test scores of all of these participants, those aged 25 to 65 tested in 1942 and those aged 25 to 65 tested in 1992, and plotted them by birth date. This gave him scores for people born all the way from 1877 to the 1970s (Raven et al., 1993, Graph G2).

The birth-date method of estimating trends over time entails the assumption that performance is constant between maturity and old age; that is, Raven assumed that the 65-year-olds tested in 1942 would have received much the same scores if they had been tested as 25-year-olds in 1902. There have been no longitudinal studies of the effects of aging

<sup>1</sup>Jensen's assessment of the limitations of low IQ is not, of course, based on a single person. He said that overwhelming evidence shows the man he interviewed was typical: "Adults with an IQ below 75 can seldom manage their own affairs; they often need assistance from their families or from social agencies" (Jensen, 1981, p. 12). I hope it is plain that my own use of "understanding-baseball intelligence" is meant simply to convey how dysfunctional a society would be if 70%, or even 40%, of its members could not participate fully and autonomously in everyday life. No doubt, people can be found who understand baseball despite low IQ, but if they are being scored against current norms, there will be significant limitations somewhere. This is not to belittle those whose programs have enhanced the ability of persons with low IQ to cope. However, such programs hardly operated on a mass scale in previous generations. Even recently, Spitz (1986, p. 215) offered a word of caution: "We have no prescription that will change their capacity . . . to solve real-life challenges of some complexity."

on the Raven, but Pat Rabbitt (personal communication, September 19, 1997) is measuring the effects on Cattell's (Individual or Group Culture Fair Intelligence Test, 1960 ed.), which is a similar matrices test of fluid *g*. His results have suggested a drop of no more than 10 IQ points. Another source of error: The Raven was administered without a time limit to both the 1942 and 1992 standardization samples, but the 1942 sample took the test under supervision, whereas the 1992 sample took it unsupervised in their own homes. Raven and Gudjonsson have debated whether unsupervised administration may have inflated the 1992 scores. Comparative data, plus data from a short test each participant completed under supervision, suggest that if score inflation occurred, it was primarily among the top 10%, not extending below the 50th percentile (Raven, 1995). Therefore, I use the 5th percentile from 1992 to compare the two standardization samples.

Figure 1 shows that the bottom 90% of Britons born in 1877 fall below the 5th percentile of those born in 1967, which is to say below an IQ of 75. Assume that members of the 1877 cohort deserve an extra 10 points to compensate for the effects of aging, and throw in another point or two for good measure. This would put 70% of late-19th-century Britons below an IQ of 75 when scored on current norms. To identify IQ gains with understanding-baseball intelligence, one would have to assume that 70% of Britons could not, even if it became their chief interest, understand cricket in 1897. Even if one put the percentage at 60%, or down to 50%, would such a thing be plausible?

Moreover, data whose quality cannot be challenged have posed the same question. The Dutch military data, like those of Israel, Norway, and Belgium, are near exhaustive; but even better, Vroon compared a sample of the total population of Dutch examinees with the scores of their own fathers. There is simply no doubt that Dutch men in 1952 had a mean IQ of 79 when scored against 1982 norms. Has the average person in The Netherlands ever been near mental retardation? Does it make sense to assume that at one time almost 40% of Dutch men lacked the capacity to understand soccer, their most favored national sport?

One could argue that rather than scoring 1952 Dutch men against



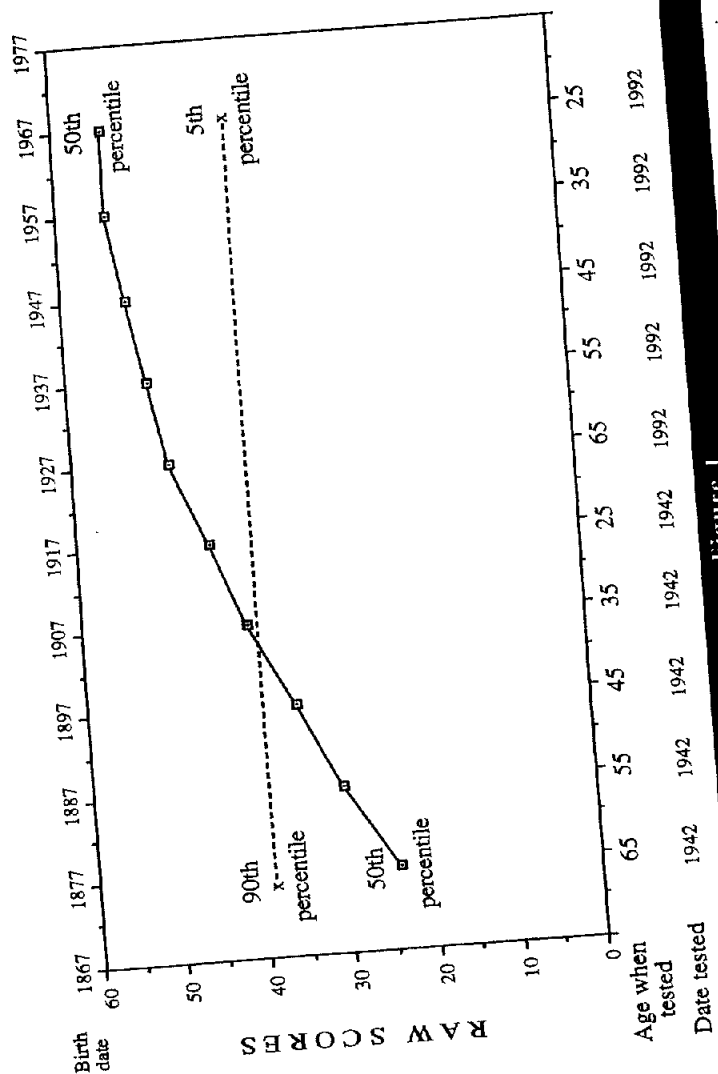


Figure 1  
Great Britain and the Raven Progressive Matrices. The bottom 90% born in 1877 fall within the bottom 5% born in 1967 (IQ 75 or below). Data from Raven, Raven, and Court (1993).

later norms, one should score 1982 men against the earlier norms, giving a 1982 mean IQ of 121. But this would entail a new problem, looking for evidence of widespread giftedness in the present generation. Dutch teachers in 1982 should have enjoyed classrooms in which over 25% of children had IQs of 130 or above, children who should have flashed through ordinary schoolwork. The number of people with IQs above 140 would have increased from 1 in 260 to 1 in 10, the sort of people whose adult achievements are so clear that they fill the pages of *American Men of Science* and *Who's Who*. However, a careful survey of serious Dutch publications revealed not a single reference to a dramatic increase in cognitive ability or escalating giftedness among schoolchildren. The number of inventions patented in fact showed a sharp decline over the last generation (Flynn, 1987a, pp. 172, 187).

These scenarios are derived from gains on tests of fluid intelligence. Jensen's participant had a Wechsler IQ of 75, and Wechsler tests measure a mix of fluid and crystallized intelligence. It may be said that such tests are a better measure of mental retardation and, therefore, that my scenarios are suspect. The next step, therefore, is to examine U.S. data from Wechsler and Stanford-Binet samples, in which all participants took tests that measure a mix of fluid and crystallized intelligence. These samples, although carefully chosen, cannot match the quality of either comprehensive or random samples. For example, the most recent measures of U.S. gains are based on the Wechsler Intelligence Scale for Children (WISC-III) and the Wechsler Adult Intelligence Scale (WAIS-III) standardization samples tested in 1989 and 1995, respectively. Participants who took both tests show that even if these two samples had been selected at the same time, the latter would have performed about 1.70 IQ points below the former. Results from the first sample suggest a recent rate of gain of just over 0.30 points per year, and results from the second, about 0.20 points per year. When sampling error of this sort produces two estimates, one can do little but split the difference and put post-1972 gains at about 0.25 points per year.

Nonetheless, the U.S. data clearly show massive gains from 1932 to 1995, and they strongly suggest that these gains began no later than 1918. Every study from the interwar era shows large gains, and



they are supported by a comparison of performance on the Stanford-Binet by soldiers in 1918 with that of the standardization sample of 1932 (Flynn, 1984b, 1993; Terman & Merrill, 1937, p. 50; Wechsler, 1992, p. 198; 1997; Yerkes, 1921, pp. 654, 789). As Figure 2 shows, White Americans gained almost 25 points on Wechsler-Binet tests between 1918 and 1995.<sup>2</sup> This means that in 1918, when scored against today's norms, Americans had an average IQ of 75 on tests in which the crystallized component is at least as great as that of the Wechsler tests. Does that mean that during World War I about half of White Americans lacked the capacity to understand the basic rules of baseball?

It is now possible to make some decisions about what package of IQ gains plus other enhanced skills poses a problem of causal explanation. Some enhanced skills one expected to accompany IQ gains can be excluded simply because the enhancement has not occurred. Recall the three schoolchildren sitting in a row who belong to the same generation. The escalation of cognitive skills associated with IQ differences, going from a child with IQ of 75, to one with IQ of 100, to one with IQ of 125, is not in evidence when one compares generations over time. Wechsler subtests, going back as far as 1948, show no gain for arithmetic reasoning, some gains for nonspecialized vocabulary in West Germany and Vienna (but such gains were small or nil in English-speaking nations), and negligible gains for nonspecialized general information. If one regards the present generation as if it were a gifted class with a mean IQ of 125, where are the reports from teachers of long experience that children today surprise them with their speed of learning and sheer

<sup>2</sup>The estimate for 1918-1932 is based on a comparison between the 1918 White draft and the 1932 Stanford-Binet standardization sample, mental ages of both calculated in terms of 1916 Stanford-Binet norms, plus regional studies from that period; all of which show gains greater than those represented in Figure 2. Storfer (1990, pp. 89-94) analyzed Stanford-Binet data, military data covering the period between World War I and World War II, and longitudinal studies and concluded that substantial IQ gains began in America in the early 1890s. The estimates for the decades 1930-1970 are based on numerous comparisons of Wechsler and Binet standardization samples, as noted above. The post-1970 estimates, terminating in 1995, are based on the WISC-R (1972) to WISC-III (1989) estimate and the WAIS-R (1978) to WAIS-III (1995) estimate. These overlap so much, and cover so great a portion of this period, that they were both treated as comprehensive and averaged.

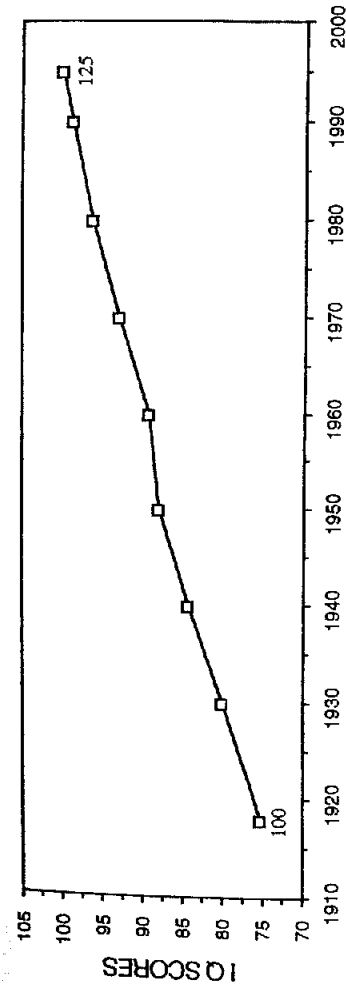
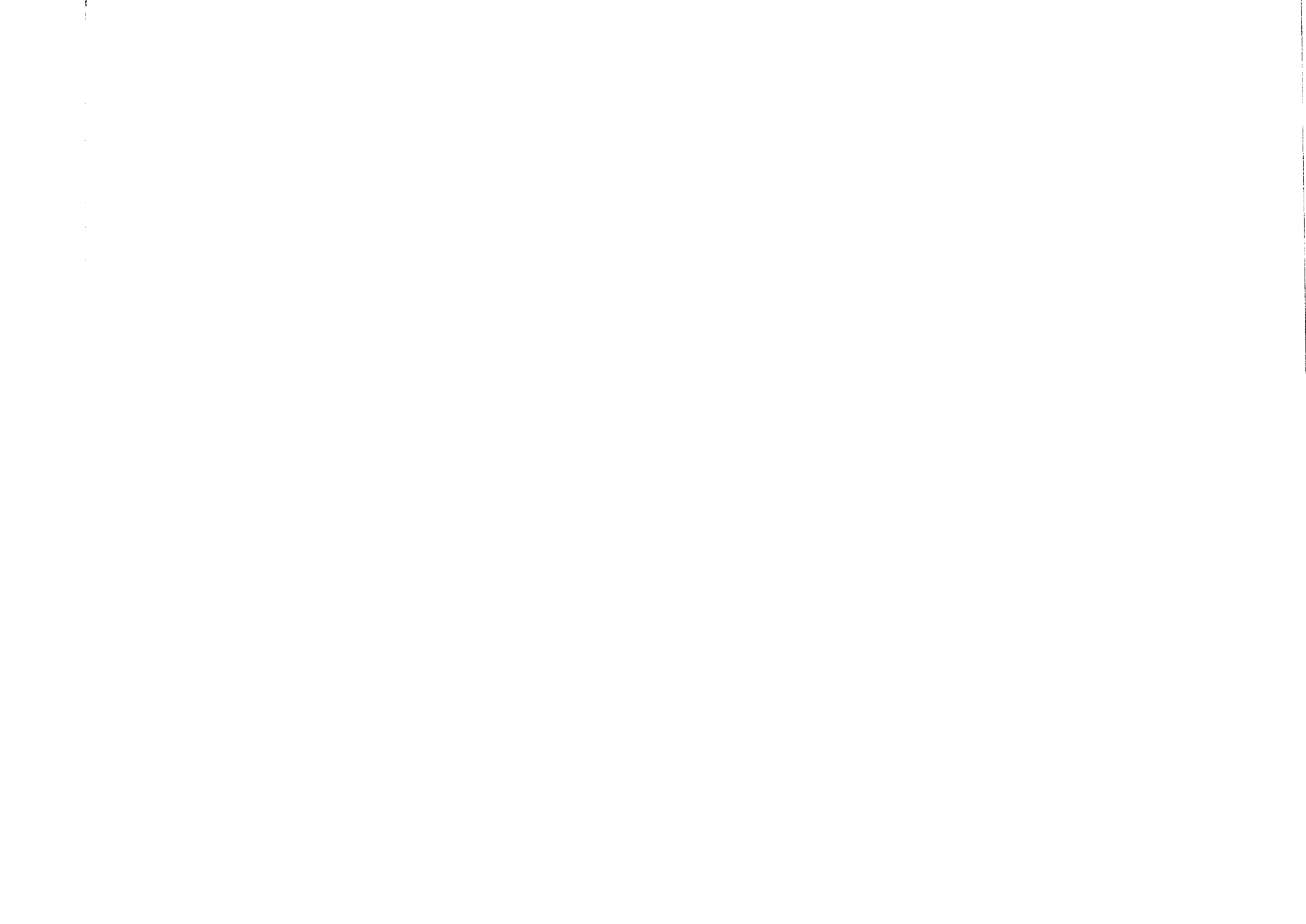


Figure 2

The United States and Wechsler-Binet tests: Whites gained 25 IQ points from 1918 to 1995. A previous graph was revised and extended to accommodate the WAIS-III standardization sample. American gains on Wechsler-Binet tests do not break down into discrete time periods like Raven's gains; for example, in The Netherlands, virtually the total 18-year-old cohort was tested every 10 years. The data are compiled primarily from studies in which what appear to be representative samples (the draft, standardization samples) can be compared as to the norms set. I have estimated rates of gain decade by decade, but this must not conceal the fact that any time periods chosen involve merging various estimates and taking averages. For example, if a rate of gain from a pair of standardization samples overlaps with 7.5 years of a decade, its rate is multiplied by 7.5 and a rate from another pair of samples might be multiplied by 2.5; then a weighted average could be calculated for the full decade. The mechanics are spelled out in Flynn (1984b). From "Get Smart, Take a Test," by J. Horgan, 1995, 273(5), p. 14. Copyright 1995 by Scientific American. Adapted with permission from publisher and artist.



intelligence? The present generation at adulthood, at least in The Netherlands, patents fewer inventions. If one treats past generations as if they were a special-needs class with a mean IQ of 75, one finds no evidence of widespread problems in coping with everyday life. The frustration of our within-generation expectations, concerning enhanced cognitive skills, seems to imply that IQ gains have not been accompanied by intelligence gains.

I do not deny the existence of other important trends: the rise of computer skills, the larger number of people going on to universities and learning more advanced subjects, the larger number of scientists. In my view, these trends no more lead to an expectation of enhanced intelligence than they do when certain people are advantaged over others within a generation; recall the advantages of the first child to get a home computer or those who attended Catholic schools. I would label such trends as enhanced *achievement* and *learning*. However, to insist on my preferred labels would be to violate my fundamental purpose. Call the new skills and educational and scientific progress enhanced *intelligence*, if you will. The labels are not important, but what is important are the contents of the package. The fundamental question is this: Will it be productive or counterproductive to bundle up such enhanced skills with IQ gains *for the purpose* of seeking causal explanation?

After all, over the past 50 years, historians and social scientists have provided detailed explanations of educational and scientific progress. But not one of them used their hypotheses to deduce a prediction of IQ gains over time or even suggested looking for such. This seems odd, if the two explanatory tasks have much in common. Bundling together the wrong phenomena for causal explanation can be a distracter. It made sense to seek a common origin of the movement of the tides and the motions of Mercury, but it would have been a distracter to include the problem of why a stick looks bent when it is half in and half out of water. Granted that this example could be used to suggest that one is wise only after the event. Even though dogmatism is not in order, I believe that bundling up IQ gains with scientific and educational progress is a bad bet.

## THEORY AND PRACTICE

It would be a mistake to think that the only important thing about massive IQ gains is providing causal explanation. Therefore, I interrupt the analysis to say a few words about theoretical and practical implications.

Massive IQ gains over time pose a direct threat to the Spearman-Jensen theory of intelligence. That theory is based on *g*, the general intelligence factor derived from the tendency of the same people to excel on a wide range of IQ tests and items. The Raven is the test that best operationalizes *g*, that is, shows that *g* refers to a coherent set of mental abilities (Flynn, 1987b). Jensen (1987, pp. 380-381; 1991, pp. 59-60, 68-69) himself has accepted that IQ gains over time are too great, even on tests whose credentials as measures of *g* are impeccable, to be equated with intelligence gains. The huge gains on the Raven are, of course, especially troublesome. Some years ago, Jensen (1980) envisaged tests running from the detour problem (finding one's way around a barrier) through an adapted form of the Raven, which would allow one to measure the intelligence of cats and chickens, Kalihari Bushmen and polar Eskimos—even extraterrestrials. Today, we have reason to suspect that the Raven cannot compare the Dutch of 1982 and the Dutch of 1952 for intelligence, perhaps not even the Dutch of 1982 and 1972.

Problems remain even for those who abandon *g* but who accept the distinction between the Raven as a measure of fluid intelligence and the Wechsler-Binet tests as adding the dimension of crystallized intelligence. Theory posits a functional relationship between these two, so that a problem that afflicts one transfers to the other. Take the problem of putting past generations at a mean IQ of 70 or 80 on tests of fluid intelligence. Such populations should not be capable of soaring much above that for crystallized intelligence, the skills they need to deal with the real world. It is quite possible that people whose fluid intelligence did not decline until old age should retain the information and vocabulary they acquired earlier, at a time when their fluid intelligence was normal. The evidence of many studies suggests that this is true (Horn, 1989). However, it is quite another thing to imagine people acquiring normal levels of knowledge and vocabulary if their fluid intelligence





never, during their entire lives, rose much above the level of mental retardation.

Flynn, (1992, in press) gave an overview of the full range of practical implications of massive IQ gains over time, but I highlight a few examples here. Between 1948 and 1972, the period between standardizations of the WISC, IQ gains lowered the number of American children eligible to be classified as mentally retarded from 8.8 million to 2.6 million. There is no evidence in the literature that clinical psychologists were aware of this (Flynn, 1985). The recent WISC-III manual gives a criterion for learning disabilities or reading disorders in terms of differential performance on four subtests (Wechsler, 1992, pp. 212-213). Thanks to differential gains over time on those subtests, perfectly normal children are in danger of misdiagnosis.

Vernon (1982) analyzed studies of Chinese Americans in which they were scored not against their White contemporaries but against the lower performance of Whites from previous decades. This made Chinese Americans appear to be an IQ elite when, in fact, they had no higher mean IQ than White Americans. Despite this, Chinese Americans have outperformed White Americans academically and occupationally by huge margins (Flynn, 1991). Massive IQ gains add viability to an environmental hypothesis about the IQ gap between Black and White Americans. It appears that the former have enjoyed a slightly higher rate of gain than the latter (Herrnstein & Murray, 1994, pp. 276, 292). This implies that since 1945, Blacks have gained at an average rate of over 0.30 points per year and gained a total of 16 points over 50 years. So the Blacks of 1995 should have matched the mean IQ of the Whites of 1945. Therefore, an environmental hypothesis need assume only that the average Black environment of 1995 matches the quality of the average White environment of 1945.

### CAUSAL HYPOTHESES

Scholars are accustomed to providing causes of within-generation IQ differences, such as the IQ differences that separated the three children attending school at the same place and time. They are tempted to regard

the problem of explaining between-generation differences as similar. However, the two phenomena are radically differentiated by the fact that the link between IQ and other cognitive abilities, so firm within generations, has snapped between generations. The breaking of that link, the fact that IQ gains are simply not attended by the enhancement of most of the real-world cognitive skills one might expect, creates a peculiar criterion for evaluating the plausibility of causal hypotheses. Throughout this section, I use the label *intelligence* to refer to the missing real-world cognitive skills, but it has only that significance, nothing more.

Factors that are evidentially weak, such as test sophistication or personal irresponsibility (see **The Brand Hypothesis**), qualify as plausible simply because they might raise IQ scores without raising intelligence. Factors that prima facie look evidentially strong, such as nutrition, are labeled implausible simply because they could not possibly raise test scores except through the vehicle of enhanced intelligence. Then there are factors like socioeconomic status (SES) and urbanization that must be given a peculiar formulation to qualify as plausible. Higher SES is thought to be correlated with higher IQ scores for two reasons: Competition within a generation for high status ranks people for intelligence without enhancing the overall level of intelligence; the better environment high SES provides perhaps enhances intelligence. The first rationale does not apply between generations because past and present generations do not compete. The second rationale would have to be modified to read that SES environmental gains between generations raise IQ scores without raising intelligence. The case for urbanization as a factor would have to be reformulated in exactly the same way. The plausibility of education is less affected, that is, less affected by the lack of association between IQ and real-world cognitive skills.

I review the cases for the factors just named, trying to strike a balance between citing the broken link when it is relevant and ignoring it when it gets in the way of evaluating evidence on its merits. The factors reviewed are environmental rather than genetic: Only a fanatic eugenics program could have made a significant contribution to IQ gains, and if anything, mating trends have been dysgenic (Lynn, 1996).



Increased outbreeding, as local communities became less isolated between 1850 and 1950, may have been a quasi-genetic factor, but it is unlikely that it could be used to explain post-1950 gains in advanced European nations.

### Test Sophistication

The 20th century has seen a change from totally unaware participants to people bombarded by standardized tests, and undoubtedly, a small portion of gains in most nations is explained by test sophistication. However, its role must be relatively modest. Gains antedate the period when testing became common and have persisted into an era when IQ testing, owing to its unpopularity, has become less frequent. More to the point, even when naive participants are repeatedly exposed to a variety of tests, IQ scores rise by only 5 or 6 points, and the rate of gain reduces sharply after the first few exposures. It would be difficult to put British gains at less than 30 IQ points, and some nations, like The Netherlands, show the rate of gain escalating decade after decade.

### The Brand Hypothesis

Brand (1987a, 1987b) argued that the permissive society advantages the present generation as test takers. He considered it significant that IQ gains are correlated with increasing rates of sexual promiscuity, illegitimacy, divorce, irreligiosity, cigarette consumption, accidents, and crime, as well as with Britain's leadership in the field of popular music. The last generation was scrupulous and painstaking; the present generation tends toward personal liberalism. The former wasted time trying to get every item correct; the latter are prone to intelligent guessing and finish more items within the time allotted. The former, even when tests were untimed, became demoralized when they could not answer a hard item and did not persist to answer subsequent easy items; the latter skim hard items and persist.

This hypothesis is theoretically ideal. It explains IQ gains in terms of something that implies no intelligence gains and cites environmental factors independent of mere exposure to tests. However, it has now been proved false. John Raven analyzed his own test and reported that

responsible test takers persist to the end. In addition, people do not get items right or wrong by guessing but by mastering or not mastering rules that govern the orderliness of the matrix (Raven, Raven, & Court, 1995, p. G59). On the test Brand chose to evidence his hypothesis, the Verbal scale of the WISC (a test exerting little time pressure), Scottish children in fact made a generational gain of fully 13 IQ points (Flynn, 1990). Flieller, Jautz, and Kop (1989, pp. 11-12) analyzed a Binet-type test with a fairly even balance of timed and untimed items. They found that the last generation left more questions unanswered on both kinds of items and that worse performance on items completed accounted for virtually all of the last generation's score deficit.

### Nutrition

The nutrition hypothesis cannot be bettered as an example of the peculiar problem of explaining IQ gains over time. Better nourished brains would function better in the test room but only because they also functioned better in everyday life. Therefore, if improved nutrition has caused IQ gains of 20 or 30 points, one would be driven to posit huge understanding-baseball intelligence gains.

Richard Lynn (1987, 1989) enhanced the plausibility of this hypothesis by ascribing only a portion of IQ gains to nutrition. He ascribed the remainder to other causes such as defective tests. For example, the Raven is held to measure increased arithmetic skills as well as intelligence gains and therefore to overestimate intelligence gains. The critique of the Raven poses many evidential problems. Norwegian draftees made matrices gains while suffering losses on a test modeled on the Wechsler adult arithmetic subtest. Military samples from Israel showed comparable male and female performance on the matrices, which runs counter to most gender data concerning mathematics. As for the magnitude of matrices gains, they are larger than those of other nonverbal tests in Britain but equivalent in Belgium and smaller in Australia, Canada, and Scotland (Flynn, 1987a, pp. 173-174, 176, 1990; J. Goldenberg, personal communication, March 4, 1991).

Even if given a diminished explanatory role, the nutrition hypothesis has its own peculiar evidential problems. Lynn (1987, p. 467) fo-



cused on Britain. He cited a height gain of 1 *SD* over the last 50 years; this equals his estimate of British intelligence gains over that period, that is, 15 points. However, some European countries have been reporting height gains for fully a century or two, and these amount to more than 1 *SD*, sometimes to 2 or 3 *SDs* (Floud, Wachter, & Gregory, 1990, pp. 16, 23, 26). If height gains are truly accompanied by intelligence gains, they pose a familiar question: Did the Dutch in 1864 really have the same intelligence as people who today score 65 on IQ tests? Did Norwegians in 1761 really resemble those who today score 62?

The best experimental study of the effects of vitamin-mineral supplements on IQ showed that in California, a modest supplement had little effect, a moderate one had a significant effect, and a large one had little effect (Schoenthaler, Amos, Eysenck, Peritz, & Yudkin, 1991, pp. 357-358). That every nation has continuously enhanced nutrition just the right amount, neither too little nor too much, for decade after decade, seems unlikely. Moreover, historic nutritional fluctuations have sometimes proved "impotent." The Netherlands almost certainly provided children born after World War II with better nutrition than it provided those born during the great wartime famine. The effect on IQ gains of the fluctuating nutritional quality over time was nonexistent (Flynn, 1992, p. 346).

The experimental data concerning dietary supplements also have shown that 75% of participants enjoy very modest gains, whereas 25%, presumably persons who are subclinically malnourished, make large gains. The latter tend to have lower IQs than the former, which means that if enhanced nutrition is a factor, IQ gains over time should come disproportionately from those with below-average IQs. Denmark's data fit that pattern, but the data of most nations do not. A good sign that IQ gains extend to every IQ level is that score variance remains unchanged over time or diminishes only because of clear ceiling effects. Military samples or samples of equivalent quality show this pattern for Belgium, Norway, Sweden, Israel (men), Canada, and New Zealand. Dutch Raven's data and U.S. Wechsler data provide the full IQ curves and allow one to verify gains at all levels (Bouvier, 1969, pp. 4-5; Clarke, Nyberg, & Worth, 1978, p. 130; Elley, 1969, p. 145; Emanuelsson

& Svensson, 1990; Flynn, 1985, p. 240; J. Goldenberg, personal communication, March 4, 1991; Rist, 1982, p. 47; Teasdale & Owen, 1989, pp. 258-259; P. A. Vroon, personal communication, November 5, 1984).

### The Storfer Hypothesis

Storfer (1990) made an attempt at causal explanation that has much in common with that of Lynn, although he added an unusual twist at the end. Once again, only a portion of IQ gains are to be identified with intelligence gains, this time 22 points (rather than 15). Once again, the remainder is ascribed to defective tests. This time the Raven is held to be a spatial test measuring a peripheral rather than a core component of intelligence. I believe that the Raven may have a spatial memory component if administered with great time pressure, but the component is small. Jensen (1980, pp. 646-647) called the notion of a significant spatial component a "common misconception" and emphasized that, factorially, the Raven measures fluid *g* and little else. Storfer cast doubt on the concept of so-called fluid intelligence and argued that only tests heavily weighted toward crystallized intelligence are true measures of intelligence. The theoretical price to be paid for downgrading fluid intelligence has already been discussed. The plausibility of even a 22-point intelligence gain is not directly confronted. That is, rather than discussing the consequences of putting the mean IQ of this generation's grandparents at 78, in terms of today's norms, the usual within-generation evidence for the validity of IQ tests is cited.

Storfer (1990) supplemented improved nutrition as a cause with factors like the eradication of childhood diseases and improvements in the cognitive quality of the preschool home environment. He argued that in the United States, when acting purely as environmental variables, these factors could explain an 11-point intelligence gain since 1900. The analysis takes within-generation data and applies them across generations by making certain assumptions, such as that half of American infants were in unfavorable home environments in 1900 compared with only 20% today. As I have demonstrated, the assumption that the within-generation potency of a factor holds between generations is sus-



pect, particularly when extended to factors like favorable versus unfavorable home environments.

The 11 points supposedly explained fall well short of the 22-point intelligence gain Storfer posited. He doubled the explanatory potential of his factors by formulating a new Lamarckian theory of evolution, citing cholinergic neurons as the vehicle for the inheritance of an acquired characteristic. These neurons might convey an environmentally induced change in the brain cells to the testes, allowing that change to be passed from one generation to the next. There is no harm in this sort of speculation, but acceptance awaits anatomical and biochemical evidence. Until then, there is no substantial body of evidence to assess.

#### SES and Urbanization

Enhanced SES over time should capture something of the improved home environment Storfer and many others have posited. Whatever role SES played in the first half of the 20th century, the eternally puzzling Dutch data imply little impact since 1950. de Leeuw and Meester (1984, pp. 14, 16, Figures 5, 7) provide data that allow an estimate of SES gains from 1952 to 1962 as measured by father's occupation. When projected over 30 years, this amounts to 1.18 SDs. The correlation between father's occupation and son's IQ is .33 (de Leeuw & Meester, 1984, pp. 13, 16); therefore, SES gains might appear to account for 5.84 of the 20-point Dutch generational gain ( $1.18 \times .33 = 0.3894$  SD units;  $0.3894 \times 15 = 5.84$  points). However, the correlation between father's occupation and son's IQ may not represent a causal link: When P. A. Vroon controlled for father's IQ and father's education level, variables with a high genetic loading, the path correlation between father's occupation and son's IQ was .02, or virtually zero (P. A. Vroon, personal communication, October 9, 1984). A generous estimate for SES, as an environmental variable, would be that it caused a 3-point IQ gain in the current generation.

The best data on urbanization, or the migration of people to cities, come from Flieller, Saintigny, and Schaeffer (1986), covering the years 1944 to 1984. They estimated that French 8-year-olds gained 24 IQ points (1.6 SDs) over those 40 years on a Binet-type test. Their occupational breakdown evidences the IQ deficit of the children of farmers

and other rural workers. Using algebra, one can show that even if urbanization totally eliminated these occupations, only 3.2 points of the 24-point gain would be explained. Calculation of the IQ gain of children whose parents had urban occupations gave a similar result: Only 3 points of the total sample's gain disappeared. The authors also provided data that show more preschooling accounting for 3.75 points, test sophistication for 1.81 points, and enhanced SES for 1.37 points. Simply adding the values for these four variables accounts for 10 of the 24 points explained, but the results would be heavily confounded. The shift from rural to urban living would in itself account for much of the rise in preschooling, test sophistication, and SES. No precise estimate of the effect of the total package is possible, but an estimate of 6 points is plausible and tallies with the Dutch data. There, 5 points out of 20 were explained by a package of SES plus test sophistication plus more education (Flynn, 1987a, pp. 188-189).

#### Education

Education seems an obvious cause because, at its best, it awakens the mind and teaches students to analyze and criticize. During the 20th century, semiformal and formal education have been extended down into the preschool years and upward into adulthood. Using Stanford-Binet data for 1932 to 1971-1972, Thorndike (1977) concluded that American children aged 6 and younger have made greater IQ gains than older children. Therefore, he sought causal factors likely to affect preschoolers more than others such as TV in general and educational TV in particular. Flynn (1984a) compiled a wider array of data that showed that the atypical gains of young children were either an artifact of sampling error or antedated 1947, ruling out TV as an age-specific factor. Moreover, he used the WISC standardization sample to compare American IQ gains from 1932 to 1947-1948 with those from 1947-1948 to 1972, the periods immediately before and after the introduction of TV. The rates of gain for both periods were roughly equal. Lynn (1987) has hypothesized that children who grew up during the Great Depression and World War II may have had their IQs depressed. If so, the WISC standardization sample of 1947-1948 would have had an atypically





poor performance, which would deflate estimated gains prior to the introduction of TV and inflate the estimate for the period thereafter. In other words, TV might have lowered IQ gains, an effect concealed by the depressed performance of the WISC sample. However, there is ample international data that show massive gains for people born after World War II, which counts against the depression-World War II hypothesis (Flynn, 1988, p. 349, 1990; J. Goldenberg, personal communication, March 4, 1991; Lynn, 1990; Wechsler, 1992, p. 198). There is no reason to believe that TV either increased or reduced the rate of IQ gains in the United States.

Every one of the 20 nations evidencing IQ gains shows larger numbers of people spending longer periods of their life being schooled and examined on academic subject matter. IQ gains in Denmark appear highly correlated with increased years of schooling and more people attaining higher credentials (Teasdale & Owen, 1989). However, the reverse is true in The Netherlands, where matching across generations to hold educational level constant eliminated only 6.5% of a massive gain (Flynn, 1987a, p. 188). Gains among schoolchildren, on the basis of comparing 6th or 12th graders with their counterparts of a generation ago, cannot be influenced by years of schooling because the number of years is by definition the same.

As for quality of schooling, some educational reforms may actually have impeded IQ gains. Rist (1982, pp. 56-58, 63) noted that when students trained in the new math reached military age, Norwegian gains on a math test, modeled on the Wechsler Adult Arithmetic subtest, turned into losses. Setting that aside, those who endorse quality of schooling as a factor must argue the following: either that better teaching of the learned content of an academic curriculum has raised IQ or that better teaching of decontextualized problem-solving skills has raised IQ (Cole & Means, 1981; Scribner & Cole, 1981; Sharp, Cole, & Lave, 1979). I now examine those two subhypotheses.

The first subhypothesis, concerning better teaching of school-learned content, has already been falsified by the pattern of IQ gains over time. As I have shown, gains drop as one goes from Raven's type tests to performance tests to verbal tests to Wechsler subtests like

Arithmetic, Information, and Vocabulary. This implies that the gains tend to disappear when material closer to the learned content of the school curriculum is tested.

This leaves the second subhypothesis, namely, that schools are teaching better decontextualized problem-solving skills. Perhaps they are, but the hypothesis is empty unless (a) these school-taught skills are identified; (b) they are linked to the problem-solving skills used on IQ tests, particularly culture-reduced tests of fluid *g*; and (c) they are linked to some kind of real-world problem solving or, the greatest puzzle, it is explained why there is no such link. The very fact that children are better and better at IQ test problems logically entails that they have learned at least that kind of problem-solving skill better, and it must have been learned somewhere. However, simply to assert that the enhanced IQ test skill can be equated with some enhanced school skill is arbitrary and vacuous.

The fact that education cannot explain IQ gains as an international phenomenon does not, of course, disqualify it as a dominant cause at a certain place and time. Particular countries are sometimes influenced by a factor that is culture specific. Comparing age cohorts has suggested that the urban Chinese gained 22 IQ points on the Raven Progressive Matrices between 1936 and 1986 (Raven & Court, 1989, p. RS4.8). Learning to read Chinese characters involves memorizing complex symbols, combining them to alter meaning and signal pronunciation, and taking such tasks seriously. The literacy that follows urbanization might be an important cause of matrices gains peculiar to China.

#### Evaluation of Causal Hypotheses

It is logically possible that peculiar factors dominate in each and every one of the 20 nations: years of schooling in Denmark, urbanization in China, perhaps test sophistication in Brazil, and so forth. However, the universal pervasiveness of massive IQ gains and the fact that there are such striking counterexamples to these factors make this highly unlikely. I believe it is fair to say that up to now, efforts to identify the environmental factors that have caused IQ gains have not come to much. The



tendency has been to take the massive IQ gains since the last century, carve out a small portion to be treated as an intelligence gain, try to explain that portion by familiar within-generation factors, and treat the remainder as a nonintelligence gain caused by faulty tests. The tests castigated, it is worth noting, were hitherto considered reliable and central to the theory of intelligence. If that is a fair summary, new departures—new research strategies—are necessary.

### RESEARCH STRATEGIES

I intend to discuss five new research strategies. First, Arthur Jensen is experimenting with using behavioral and physiological variables to measure intelligence. He hopes these will not generate the theoretical and practical problems that IQ gains pose for IQ tests. Second, if there are national differences in terms of rates of gain, one might find something present in a nation with a high rate but absent in a nation with a low rate. Third, it might be possible to "rerun history" since the industrial revolution by studying a nation whose locales range all the way from untouched by industrialization to fully modern. Fourth, if IQ gains differ in terms of age, one might find something present at one age but absent at another. Finally, perhaps one can add to the package of enhanced cognitive abilities. Clarifying the effects to be explained may well provide a clue as to causes. There will be more on this last possibility at the end of this chapter.

#### Jensen and Physiology

Jensen believes that IQ tests normally measure intelligence, but that when used to compare generations, they are sensitive to factors that distort the measurement. He called on the analogy of measuring height by using shadows (Bower, 1987). At a particular time and place, shadows can rank people for height with considerable accuracy. But if one made comparisons over time, compared shadows in summer with shadows in winter, the latter would be longer and would register height gains that were spurious. The distorting factor to which shadows are sensitive is, of course, the angle of the sun's rays.

Therefore, Jensen (1988, 1989) is experimenting with behavioral and physiological variables that show correlations with IQ, the electrical response of the cerebral cortex to sights and sounds, how quickly people can react to stimuli, the time taken for an injection of glucose to reach and be absorbed by the brain. The logical culmination of this process would be the replacement of IQ tests by a battery of chronometric and physiological tests. Although the prospect of such a revolution is exciting, the new battery would have no real value unless it could outperform existing tests as a measure of intelligence; therefore, it must be assessed in terms of external validity, and that assessment may lead to ambiguous results.

I take up Jensen's analogy. It replaces IQ as a measure of intelligence with shadows as a measure of height. Because shadows have proved unreliable measures over time, from summer to winter, the search for physiological correlates begins. Imagine that someone discovered a physiological correlate of shadow differences, such as pulse rate. Would it make sense to replace shadows with pulse as a measure of height? It would not if pulse were as sensitive to the seasons as shadows are; for example, the pulse rate may rise in winter. But even if it is less sensitive, it might be worse than shadows as a measure of height in most cases. At a particular place and time, the relationship between height and shadows is strong. The correlation between height and pulse might be low: The hearts of tall people may tend to work harder but not that much harder. In addition, to make the situation truly analogous to IQ, one must assume that these people have no direct measure of height, just as IQ tests give no direct measure of intelligence. All people have are the criteria of external validity that gave them confidence in shadows in the first place. Shadows usually predict who can reach a given shelf without a stepladder, who can vault a particular fence, and so on. If pulse gave worse predictions, they would reject it as a crude measure of height, even for the purpose of comparing height differences between summer and winter. Would they assign it the more modest role of providing a warning sign that seasonal shadow differences cannot be equated with height differences? They already have plenty of warning signs: People can no more dispense with



stepladders in winter than in summer, and they are no better at vaulting fences.

To return to the world of IQ, one does not know whether scores on chronometric and physiological tests would remain unchanged if one tested representative samples of two generations. But even if they did, that would not establish their credentials as measures of intelligence. Achievement test scores correlate with IQ and have been relatively stable between the generations; yet, they are almost certainly worse measures of intelligence than IQ. There should be no presumption in favor of physiological correlates as such, so long as people are ignorant of the physiological processes that establish the correlation with IQ. As for the physiological tests playing the role of providing warning signs that IQ gains cannot be equated with intelligence gains, people already have the only warning sign they need. Despite massive IQ gains, this generation does not exhibit the enhanced arithmetic reasoning, vocabulary, creativity, and speed of learning one would normally expect.

If chronometric and physiological tests are to be accepted as better measures of intelligence than IQ tests, they will have to be assessed against the usual criteria of external validity, which means walking the long hard path blazed by Binet. Do their scores rise with age at least to maturity? How do they correlate with teacher estimates of ability, achievement test scores, SES, upward mobility of sibling versus cosibling, and so forth? I suspect that they will fall below Wechsler-Binet tests in these assessments and below the Raven itself. Here the example of the Raven is instructive. Jensen (1980) argued that the Raven does not predict achievement as well as Wechsler-Binet tests because it is too "factor pure": It measures intelligence alone and screens out other factors that contribute to achievement such as motivation and education. The new tests are being groomed to replace the Raven as measures of intelligence or *g*. If they are even less predictive of achievement, they will pose a choice: Are they less adequate measures of intelligence because of physiological processes of which people are ignorant, or are they better measures of intelligence because intelligence has less causal potency for achievement than suspected hitherto?

The theoretical problems surrounding physiological measures are great (Flynn, 1987b), the practical problems of their administration are even greater. Gunning electrodes onto children's scalps and injecting glucose may provoke consumer resistance. If IQ tests remain as the mainstream measures of intelligence, no physiological research strategy can substitute for knowledge of the causes of IQ gains. Somewhere out there, environmental variables of enormous potency are creating IQ differences: score differences that seem to have little more to do with intelligence than the score differences caused by test sophistication. It seems likely that these variables operate to some degree within generations as well as between generations. If so, some children are getting inflated or deflated estimates of their intelligence compared to the child sitting next to them. Therefore, the causal factors responsible are well worth knowing.

#### Looking for National Differences

The strategy of analyzing different rates of gain between nations makes sense only if the data allow for true comparisons. Only the military samples from The Netherlands, Israel, Norway, and Belgium qualify. They alone provide reliable samples (near saturation) from portions of the same period (1952-1982) for persons of the same age (young adults) taking equivalent tests (derivatives of the Raven).

Figure 3 compares the slopes of the rates of gain of those nations plus Britain. Britain only half belongs; I included it because it yields adult data for the Raven for the whole period from 1942 to 1992. Using all ages from 18 to 67, I compared the top half of the 1942 curves with the bottom half of the 1992 curves, thus discarding the top percentiles from 1992. I discarded the top percentiles from 1992 because their scores were suspect: On the one hand, they were depressed by an obvious ceiling effect; on the other hand, they were the ones, it will be recalled, who may have profited from taking the test unsupervised. The comparison yielded a gain of 27 IQ points between 1942 and 1992. Because all ages are represented for both years, this is a better estimate than was obtained using birth dates to project back to the 19th century. At any rate, taking Figure 3 as a whole, perhaps someone can find



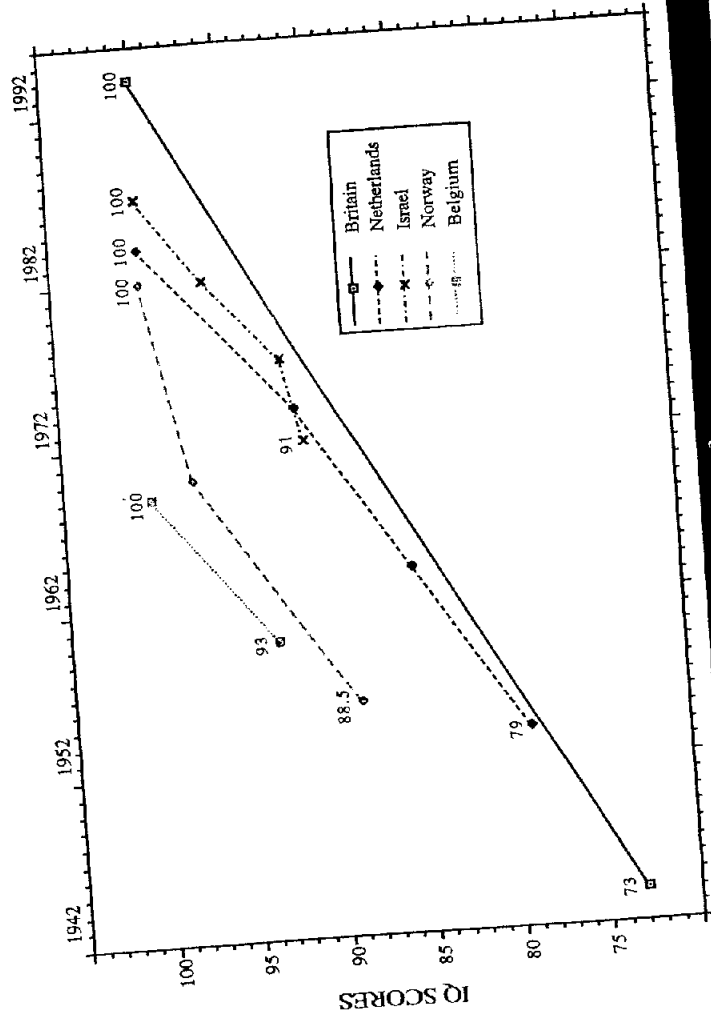


Figure 3

Five nations and matrices tests: A comparison of rates of IQ gain. Every nation is normed on its own samples. Therefore, even though nations can be roughly compared in terms of different rates of IQ gain, they cannot be compared in terms of IQ scores. That is, the fact that the mean IQ of one nation appears higher than another at a given time is purely an artifact. Data from Flynn (1987a, pp. 172-174), J. Goldenberg (personal communications, March 4, 1991), and Raven, Raven, and Constant (1993, Graph G2).

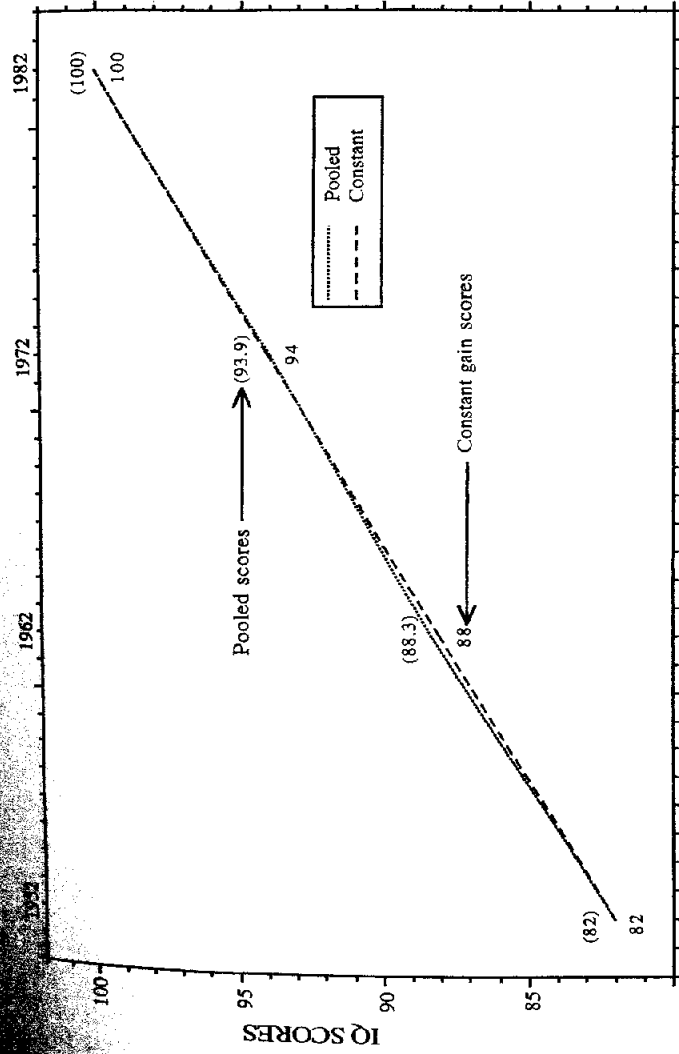


Figure 4

Pooled matrices data: Resulting rate of IQ gain compared with a constant rate of 6 IQ points per decade. British IQ gains were not measured between 1952 and 1982, which means that they had to be "uniform" within that period as a result. Therefore, whereas they were used to calculate the magnitude of the overall rate of gain, they were not allowed to reduce variations in the rate of gain from decade to decade.





significant differences among these five nations in terms of rates of gain, that is, differences that suggest causes present in some nations but absent in others. To me, the slopes are depressingly similar, the rates of gain range only from a low of 5.40 points per decade for Britain to a high of 7.78 points for Belgium.

Therefore, I decided to pool the data to see if the five nations collectively showed different rates of gain over time, that is, from one decade to another. I hoped that significant differences would emerge, for example, between 1952–1962 and 1962–1972, that would signal causal factors waxing or waning. As described at the bottom of Figure 4, the British data, which necessarily show a uniform rate transcending decades, were not allowed to have a leveling effect. Figure 4 shows that the pooled rates of gain came astonishingly close to a constant rise over the whole 30 years. With no variation in the rates of gain, it was of course impossible to look for a correlation with some variation in possible causal factors. The pattern is unsettling: It is as if some unseen hand propelled scores upward at an unvarying rate between 1952 and 1982, a rate of 6 IQ points per decade, with individual nations scattering randomly around that value.

#### Trying to Rerun History

IQ gains, or better, the factors causing IQ gains, appear to have been triggered by the industrial revolution. One cannot get into a time machine, go back and test one's ancestors, and watch them evolve as they enter the modern world. However, a nation like India shows great diversity from one locale to another, some virtually untouched by the industrial revolution, some strongly influenced, and others intermediate. One might target 10 areas so as to create a simulation of the history of the last 100 years. A report published in June 1995 put the mean IQ of Indian schoolchildren at 125 ("Children Working," 1995, p. 34). Clearly, IQ gains are occurring in India: A mean of 125 can only be a product of scoring contemporary children against the performance of lower scoring children tested some years before. Ten testing teams could provide a Raven's score map of the targeted areas, and these areas could be studied to see what causal factors kick in going from lower to higher

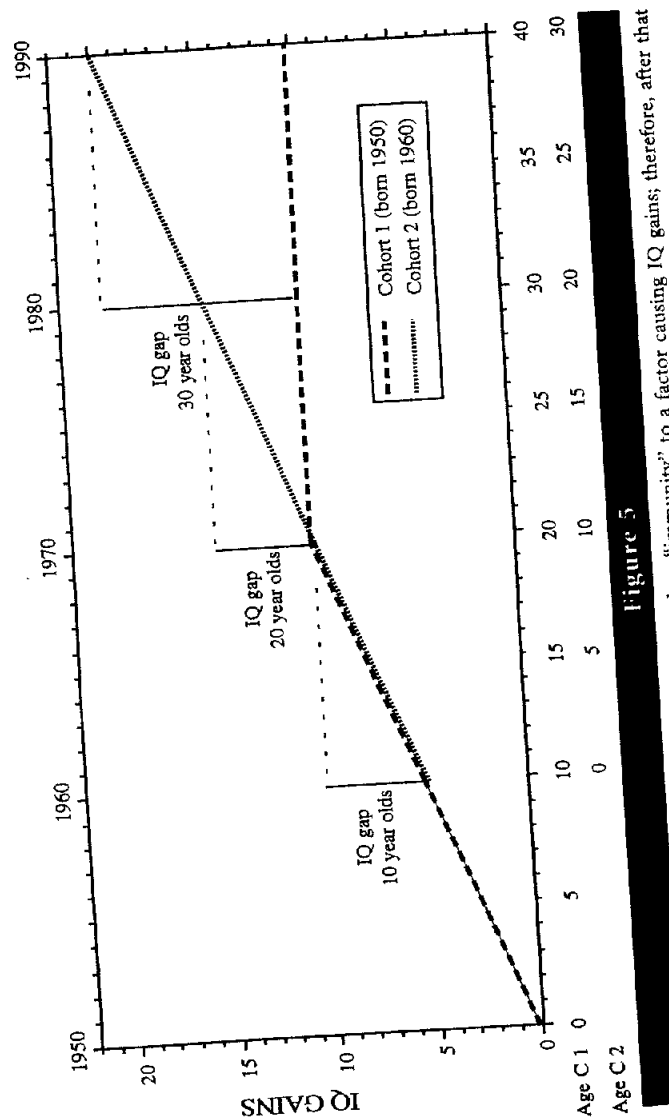
IQ areas. No one would fund such a project as a stand-alone, but it might be attached to a larger project studying the impact of industrialization on Indian society.

#### Looking for Age-Specific Differences

If IQ gains over time are age specific and show their greatest magnitude at a certain age, this might indicate either that the causal factors are more prominent at that age or that people are more receptive to them at that age. Imagine that IQ gains were greatest for children under 10. That would suggest factors like better parenting, more preschooling, and educational TV, the factors Thorndike proposed when he mistakenly thought IQ gains were evident mainly among young children. Or imagine that Raven gains escalated dramatically at 20, 30, or 40 years of age. That would suggest that over the last few generations, something had happened to enhance the on-the-spot problem-solving ability of adults. Perhaps something societal stimulated people in a different way from previous generations of adults, or something physiological made them more receptive to stimulation despite growing older. Isolating the factors responsible for unusually large age-specific gains would not, of course, explain the large gains evidenced for all ages. However, if we were lucky, the two trends—shifts over time in age receptivity and generalized gains over time—would have some causal overlap.

Figure 5 illustrates the point. Cohort 1, born in the earlier year of 1950, is susceptible to a factor escalating IQ at a constant rate of 5 points per decade, but only until the age of 20, at which point it develops an "immunity." Cohort 2, born in the later year of 1960, remains receptive to the factor beyond the age of 20. Therefore, the measured IQ gap between the two cohorts, only 5 points at ages 20 and under, dramatically jumps to 10 points at age 30. Do data exist that mimic Figure 5? The British Raven data are tantalizing: They show IQ gains between 1942 and 1992 of "only" 20 points for ages 18–32 but almost 30 points for ages 33–67. Before one gets too excited, remember that the British Raven data come from two cross-sections of all ages tested 50 years apart. Therefore, the rate of gain over time and age-specific





peak performance are hopelessly confounded in a way that only genuine longitudinal studies can cure.

Figure 5 can help to correct a common misconception. It shows that uniform presence of a causal factor at all ages produces an IQ gap fully intact in early childhood. In other words, one must not overestimate the importance of a pattern in which IQ gains do not escalate as people age (see chapter 8, this volume). Such a pattern means that the causal factors are undeniably present in early childhood but not necessarily that they impact exclusively or even mainly there. This is apparent when one considers the fate of many intervention programs. Factors that boost IQ are applied in early childhood and create an IQ gap between experimental participants and controls, but then the gap disappears as the children mature because no factors are applied after early childhood. Of course, the "IQ gains over time" boosting factor might be different; that is, it might create an IQ gain in early childhood that persists, even though the factor itself disappears and is succeeded by no later factor. However, one would know that the "IQ gains over time" boosting factor was of this special sort only after identifying it. With two possible causal explanations of an IQ gap beginning in early childhood and persisting until old age, either an early-childhood factor with permanent effects or factor(s) operating throughout life, the IQ gap itself cannot choose between them. All that such an IQ gap can tell scholars is that a causal explanation that omits factors operating in early childhood is unlikely to be true.

#### Back to Packaging Effects

It may appear that my purpose has been to reduce the package of cognitive trends to be explained to one, that is, nothing but IQ gains over time. In fact, I hope to expand the package, but I believe this must be done carefully and evidentially, without preconceptions based on the cognitive skills that normally accompany IQ.

I remain convinced that neither giftedness (the capacity to learn more quickly and make creative leaps) nor understanding-baseball intelligence (the capacity to absorb the usual rules of social behavior) has increased significantly. But even I believe that enhanced problem solving



in the test room must signal some kindred gain in problem solving in the real world, however subtle. Identifying these two effects and comparing them could provide a priceless guide from effect to cause. Let me use a sports analogy. Assume that juggling skills have dramatically escalated over time, and this takes everyone by surprise because no one has been training people to be jugglers. At first, people find no carryover to a socially significant sport, so we are baffled. Then they find that although people seem no better at football, or baseball, or basketball, they are better at the minor sport of archery. The link between juggling skills and archery skills and lack of link to other sports would identify the effect to be explained: Perhaps because of its highly repetitive technique, better juggling does not involve improved reflexes or hand-eye coordination, much less greater speed or strength; all it really involves is (like archery) a steadier hand, better concentration, lower distractibility, and more patience. So one looks for plausible causes of the latter traits rather than the former.

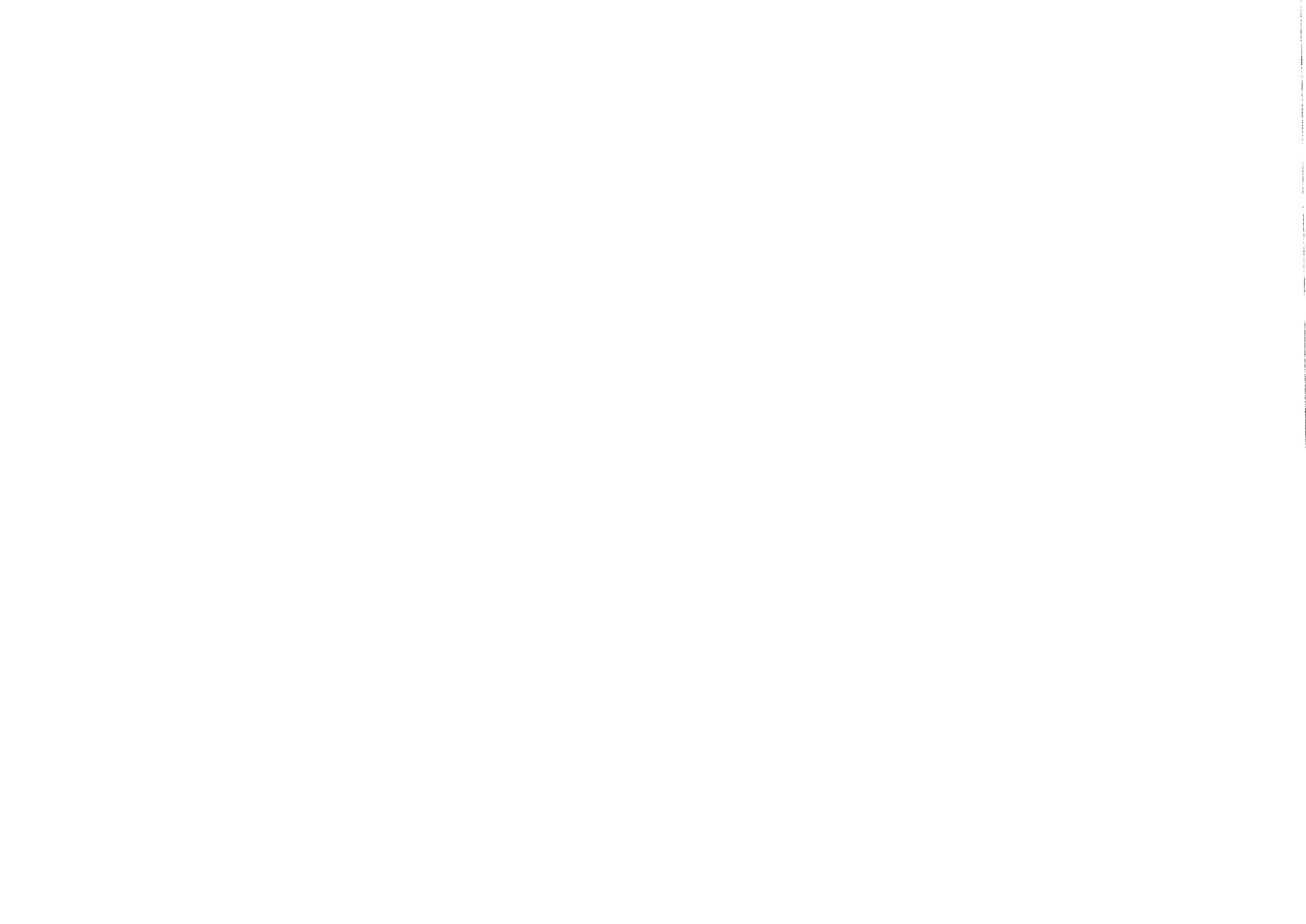
Fortunately, thanks to the work of Carpenter, Just, and Shell (1990), it is now known what cognitive skills improve performance on the Raven, namely, mastering five rules that collectively determine the element needed to complete the matrix pattern. The five rules are (a) The same value occurs across a row but alters down a column; (b) there is a quantitative pattern between adjacent entries, for example, the number of black squares in each entry increases across a row from one to two to three; (c) a figure from one column added to (or subtracted from) another produces a third; (d) three values from something like a figure type are distributed across a row, for example, diamond, square, and triangle run across rows according to a distributive rule; and (e) two values are distributed across a row, but the third value is null. The problem is how to link this test-room mastery to real-world cognitive tasks. The U.S. military has attempted to correlate mental test scores with job performance on tasks that include land navigation, use of a night-vision device, and so forth, some of which look cognitively demanding (Wigdor & Green, 1991). Perhaps they would be willing to study personnel, separated by 10, 15, or 20 years of age, and determine whether the profile of performance on such tasks varies from one cohort to another.

There is no guarantee one would perceive links between enhanced Raven skills and enhanced cognitively demanding job-performance skills. However, IQ gains as an isolated phenomenon are a dead end. So long as one is locked in the test room, the failure of explanations like test sophistication and the Brand hypothesis will leave one baffled. All my instincts tell me that a better understanding of the test skills plus discovery of associated real-world skills will produce the package of effects needed to identify probable causes.

### CONCLUSION

Massive IQ gains began in the late 19th century, possibly as early as the industrial revolution, and have affected 20 nations, all for whom data exist. No doubt, different nations have enjoyed different rates of gain, but the best data do not provide an estimate of the differences. Different kinds of IQ tests show different rates of gain: Culture-reduced tests of fluid intelligence show gains of as much as 20 points per generation (30 years); performance tests show 10–20 points; and verbal tests sometimes show 10 points or below. Tests closest to the content of school-taught subjects, such as arithmetic reasoning, general information, and vocabulary, show modest or nil gains. More often than not, gains are similar at all IQ levels. Gains may be age specific, but this has not yet been established and they certainly persist into adulthood. The fact that gains are fully present in young children means that causal factors are present in early childhood but not necessarily that they are more potent in young children than among older children or adults.

IQ gains have not been accompanied by an escalation of the real-world cognitive skills usually associated with IQ. Going from past generations to the present, one does not see an evolution from widespread retardation to normalcy, or from normalcy to widespread giftedness, take your choice. Therefore, causal explanations were divided into first, those that would explain IQ gains as an isolated phenomenon in the test room and second, those that implied an escalation of real-world cognitive skills as well. The first kind of explanation included test sophistication and altered test-taking strategies, and these were eviden-



tially weak. The second kind included nutrition, SES, urbanization, eradication of childhood diseases, historical trauma such as the Great Depression and World War 2, upgrading of the preschool home environment, educational TV, and education in general. It was acknowledged that these variables must have had some impact in the first half of the 20th century. However, since 1950, massive IQ gains have occurred in nations where only higher SES, urbanization, and enhanced education seemed to persist as significant factors. Since 1950, higher SES and urbanization, plus other trends with which they are confounded, probably account for only 5 or 6 points. Education appears to have been a potent factor in some countries but feeble in others.

Finding physiological correlates of IQ cannot substitute for better causal hypotheses. Comparative analysis is inhibited by the lack of well-evidenced national or age differences in rates of gain. The best way forward is through an analysis of what cognitive skills enhance performance in the test room and an attempt to identify similar real-world skills. The history of science shows many instances in which causal explanation awaits clarification of the package of effects to be explained.

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## Environmental Complexity and the Flynn Effect

Carmi Schooler

I have two major disagreements with James Flynn's chapter (chapter 2, this volume), neither of which has to do with his empirical conclusions. Instead, my qualms center on his unwillingness to accept the implications of what he has found. First, I question Flynn's reasons for doubting that there actually has been a major increase in the general level of intellectual functioning in industrialized societies. Second, I believe that he neglects several bodies of relevant research, much of which appeared in the sociological literature. This research not only gives credence to the view that such an increase in intellectual functioning has occurred, but provides a glimpse of the mechanisms involved producing it.

Common to both of my disagreements with Flynn is my belief that he downplays the possible importance of changes in environmental complexity in explaining his results. There is a substantial amount of evidence and considerable theoretical rationale indicating that increases in environmental complexity increase intellectual functioning and that the complexity of the environment has generally been increasing since the start of the industrial revolution.

