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Requiem for nutrition as the cause of IQ gains: Raven's gains in Britain 1938–2008

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ABSTRACT

The hypothesis that enhanced nutrition is mainly responsible for massive IQ gains over time borrows plausibility from the height gains of the 20th century. However, evidence shows that the two trends are largely independent. A detailed analysis of IQ trends on the Raven's Progressive Matrices tests in Britain dramatizes the poverty of the nutrition hypothesis. A multiple factor hypothesis that operates on three levels is offered as an alternative instrument of causal explanation.

The Raven's data show that over the 65 years from circa 1942 to the present, taking ages 5–15 together, British school children have gained 14 IQ points for a rate of 0.216 points per year. However, since 1979, gains have declined with age and between the ages of 12–13 and 14–15, small gains turn into small losses. This is confirmed by Piagetian data and poses the possibility that the cognitive demands of teen-age subculture have been stagnant over perhaps the last 30 years.

The 20th century has seen both massive height gains and massive IQ gains. Therefore, many have posited enhanced nutrition as a cause of both. We all know that even in advanced nations, the past century saw significant gains in nutrition. Nonetheless, I will argue that, at least since 1950, nutrition has not been an important factor in IQ gains, at least in developed nations. Where evidence is best, it falsifies the nutrition hypothesis; and, damning from a scholar's point of view, the hypothesis lacks explanatory potential. I will first survey what I call the global evidence, that is, evidence from general trends here and there. Then I will look at the explanatory problems IQ gains pose by a detailed analysis of their pattern in a particular nation.

1. The controversy

Lynn (1989, 1990, 1993, 1998, in press) and Storfer (1990) have both emphasized nutrition as a fundamental cause of IQ gains. Virtually everyone accepts that nutrition plays an important role in developing nations and that it did so even in advanced nations before 1950. Between the late 19th century and the mid-20th century, there were significant advances in nutrition and child health. Children's brains may have benefitted from both during their developmental stages. Well-fed and healthy children learn better at school and have more energy to learn during their leisure. All of this is granted. Debate centers on whether health or nutrition contributed much to IQ gains in American and the more prosperous European nations in the era of post-1950 affluence.

Since nutrition is the main topic of this paper, I will say only a few words about health. Since 1950, the most dramatic health gains for children in advanced nations have to do with pre-natal care, delivering infants at birth, and post-natal care including that of premature babies. Rutter (2000, p. 223) argues persuasively that these improvements have had no net effect on IQ. He argues that for every child who has escaped mental impairment, one or more impaired children have been saved who would have died without modern techniques.

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As for nutrition, to my knowledge no one has actually shown that American or British or Western European children have a better diet today than they did in 1950, indeed, the critics of junk food argue that diets are worse. Yet, post-1950 IQ gains have been very large. Military samples tested in 1952, 1962, 1972, and 1982 show that Dutch males made a 20-point gain on a Raven's-type test (Flynn, 1987, p. 172). Even the latest period shows a huge gain, that is, the Dutch 18-year olds tested in 1982 outscored the Dutch 18-year olds tested in 1972 by fully 8 IQ points. Did the quality of the Dutch diet really escalate that much in 10 years? The gains posted by the 1962 males over the 1952 males are interesting. The Dutch 18-year olds of 1962 had a known nutritional handicap. They were either in the womb or born during the great Dutch famine of 1944—when German troops monopolized food and brought sections of the population to near starvation. Yet, they do not show up even as a blip in the pattern of Dutch IQ gains. It is as if the famine had never occurred.

The major argument for nutrition as a post-1950 factor rests not on dietary trends, but on the pattern of IQ gains. It is assumed that the more affluent had an adequate diet in 1950 and that dietary deficiencies were concentrated mainly in the bottom half of the population. This has been stated as a hypothesis about class: Over the last say 60 years, the nutritional gap between the upper and lower classes has diminished; therefore, the IQ gap between the classes should have diminished as well; therefore gains should be larger in the bottom than in the top half of the IQ curve.

1.1. Top half versus bottom half

There are seven nations for which we have the whole IQ distribution from top to bottom: France from 1949 to 1974; The Netherlands from 1952 to 1982; Denmark from 1958 to 1987; the US from 1948 to 1989; Spain from 1970 to 1999; Norway from 1957 to 2002; Britain from 1938 to 2008. Denmark, Spain, and Norway show gains either larger or almost wholly in the bottom half of the curve, but France, the Netherlands, and the US show uniform gains over the whole curve (Colom et al., 2005; Flynn, 1985, p. 240; Flynn, 1987, Table 3; Teasdale and Owen, 1989; Teasdale and Owen, 2000; Sundet et al., 2004; Vroon, 1984; Wechsler, 1992, Table 6.9). Britain is a special case, which I will save for detailed analysis.

Where we do not have the full distribution, a sign that gains might be concentrated in the lower half would be that the range or variance (the S.D.) of IQ scores has lessened over time. If the lower half has gained, and the upper half has not, clearly the bottom scores will come closer to the top scores. A survey of the better data sets shows that Belgium, Argentina, Sweden, Canada, New Zealand, and Estonia have no pattern of declining variance. In Israel, males show no decline but females do; however, the female data are inferior in quality and it is hardly plausible that the latter had a worse diet than the former (Bouvier, 1969, pp. 4–5; Clarke et al., 1978, p. 130; Emanuelsson et al., 1993; Flynn, 1987, Table 5; Flynn, 1998b, Table 1a; Flynn and Rossi-Casé, submitted for publication; Must et al., 2003).[1]

Therefore, as far as we know, nutrition is viable as a causal factor in only three nations post-1950. Even in those nations, it has merely escaped falsification. There are other factors that may have been present among the affluent in 1950 and moved down to benefit the less affluent after that date, such as decent education or modern parenting characterized by a richer parent/child interaction. Even if certain nations show a decline in IQ variance, this could well be due to other factors than nutrition. For example, large families show a wider range of IQ differences among their children than small families, presumably because parents are less able to give infants attention as the number of children increases. So a drop in family size can cause reduced IQ variance.

In passing, studies of heritability pose a dilemma for those who believe that early childhood nutrition has sizable effects on IQ. The differences in nutrition would be primarily between middle-class and poor families. Yet, the twin studies show that the effects of family environment fade away to virtually nothing by adulthood (Jensen, 1998). The only escape would be data that show childhood IQ gains fading way by adulthood. Where we have adult data gains are robust. For example, Flynn (in press) analyzed gains on the WISC and Wechsler Adults Intelligence Scale (WAIS) and found that the Full Scale IQ gains[2] of children and adults were of similar magnitude all the way from 1947–1948 to 2006.

2. IQ gains and height gains

It is important to be clear about why height gains are relevant to IQ gains. It is not because of the small but persistent correlation between height and IQ amounting to about 0.20. The irrelevance of the correlation is best understood by making a dummy case for its relevance.

There is a genetic component in the height-IQ correlation, which the best data put at 35% (Sundet et al., 2005). Its causes are unknown but the orthodox speculation is sexual selection. If women prefer tall men and compete for them, the more intelligent women will have an advantage, and genes for height and intelligence will be conjoined. If taller people reproduce more successfully, this would cause a slight height gain in IQ from one generation to another. As this indicates, it really makes no difference why the correlation exists so long as the genes are conjoined and reproductive patterns favor height.

Anthropology tells us that in societies where food is scarce, obese people are admired. If they are competed for and reproduce more successfully, there will be a correlation between obesity and intelligence and a mild tendency toward IQ gains over generations. Note that the example

[1] Israel has a large enough immigration to affect results. However, the period covered is relatively brief. The best estimate of IQ gains is military testing of 17-year olds from 1976 to 1984.

[2] Full Scale IQ is considered the best overall estimate of intelligence. It is a score that sums up a person's performance on 10 subtests and compares him or her to a random sample of the population. An IQ of 100 means that you were dead average for Americans of the same age.

should cure us of a simplistic notion: that such correlations indicate a direct causal line from such physical characteristics to IQ. The mere fact that people are getting taller has no more plausibility as a cause of IQ gains than the obesity epidemic does.

As for the posited efficacy of tall and intelligent genes conjoined, it depends on the tendency of the taller to reproduce more successfully and I know of no such evidence. But we need not wait for it. As Herrnstein and Murray (1994) point out, there is a far stronger correlation between IQ and level of education that also has a sizable genetic component. We know that people with less education are reproducing far more successfully than people with more education. Any eugenic trend resting on the tendency of the taller to reproduce would be swamped by the dysgenic trend of the less educated to reproduce. And, if the less educated are shorter, and they are, it is unlikely that the taller reproduce more successfully at all.

2.1. Back to the IQ curve

In sum, the connection between height gains and IQ gains over time is significant only because it may signal nutrition as a common cause. And coupled with the assumption that nutritional gains have affected the lower classes disproportionately, this brings us back to the IQ curve. Wherever height gains persist, presumably nutritional gains persist, and where nutritional gains persist, IQ gains should show the predicted pattern, that is, gains mainly in the lower half of the curve.

This is not always the case. Martorell (1998) evidences that height gains persisted in the Netherlands until children born about 1965. Yet, cohorts born between 1934 and 1964 do not show IQ gains concentrated in the lower half of the distribution. There were massive Raven's-type gains throughout the whole range of IQs. The French gained in height until at least those born in 1965. Yet, cohorts born between 1931 and 1956 show massive Raven's gains that were uniform up through the 90th percentile.

In addition, when height gains escalate, presumably nutritional gains have increased, and the rate of IQ gains should increase. Komlos and Breitfelder (2008) have updated US height trends for those born from 1942 to 2002 and find gains from 1970 to 2002 that dwarf the up and down fluctuations of the earlier years. The oldest member of the WISC-III (Wechsler Intelligence Scale for Children - Third Edition) sample had a birth date of 1973 and the youngest member of the WISC-IV sample one of 1996. The height pattern predicts that IQ gains in the US should escalate during the period after the WISC-III. Lynn (in press) says the rate of gains was actually lower, which would be even more disastrous for the nutrition hypothesis. A lower rate of gains was a possibility I once endorsed but on the basis of incomplete data (Flynn, 1998c). Today, I put gains as constant all the way from the WISC to the WISC-IV (Flynn, 2009). But either pattern conflicts with the height trends.

2.2. Norway and twins

Norway was cited above as a nation in which the nutrition hypothesis is viable thanks to greater gains in the lower half of the IQ distribution. Actually, it counts against the posited connection between height gains and IQ gains. Height gains have been larger in the upper half of the height distribution than in the lower half (Sundet et al., 2004). This combination, greater height gains in the upper half of the distribution, greater IQ gains in the lower, poses a serious problem. Are there two kinds of enhanced nutrition, one of which raises height more than it does IQ, the other of which raises IQ more than it does height?

3. Raven's trends in Britain

The nutrition hypothesis is least convincing when IQ trends of a particular nation are analyzed in detail. The data usually reveal differential trends that can be explained only by multiple causes, and show that nutrition does not seem promising even as one cause among many. I will next analyze British trends on Raven's Progressive Matrices.[3] The data cover the period from 1938 to 2008 and I will argue in favor of multiple factors that operate on three levels of causality.

3.1. Tests and samples

The data come from three versions of the Standard Progressive Matrices (SPM). It is considered to be an excellent measure of general intelligence (Jensen, 1980). The Coloured Progressive Matrices (CPM) is designed for younger schoolchildren, primarily for those under 11 (Raven et al., 1986, pp. 2–3). About two-thirds of its items are identical with the easier items on the SPM and the other third are interspersed to give the item hierarchy a wider range. In 2008, the SPM PLUS was introduced as a revised version of the SPM. It consists of new items, most of which have been equated to match the old items in difficulty, but some are more difficult than any that appear on the SPM. All three measure on-the-spot problem solving and the ability to detach logic from the concrete (Flynn, 2009).

The CPM was normed three times and all samples were of reasonable quality.

The 1947 standardization sample was from Dumfries. Dumfries is typical of the border areas of Scotland, areas with a demographic profile approximating that of the UK. The 1979 standardization of the SPM confirmed that the norms of Dumfries closely approximated those of the UK as a whole (Raven, 1986, p. 33). All schoolchildren within the age range were tested whose names began with E through L, a total of 627 or 25% of the total Dumfries school population (Raven et al., 1986, p. 19).

The 1982 standardization sample was also from Dumfries. All schoolchildren within the age range were tested whose names began with H through L, a total of 598 (Raven et al., 1986, p. 20). The 2008 sample was a nation-

[3] The Progressive Matrices are an attempt to measure intelligence in a culturally reduced format. There is a pattern composed of supposedly easily recognized shapes. One part of the pattern is missing. Then there are six or eight pictures of candidates for the missing piece, only one of which completes the pattern.

Table 1
Coloured Progressive Matrices IQ gains by age in Britain from 1947 to 1982 and 1982 to 2007. Gains over the top half and bottom half of the curve compared where possible.

	Age in years												
	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5
1947–1982	5.04	2.82	4.23	5.73	7.83	9.40	8.11	6.41	4.70	5.69	5.69	5.46	–
Top half	8.82	5.76	7.40	8.43	11.61	13.51	11.51	8.65	5.73	7.35	6.15	–	–
Bottom half	1.27	−.12	1.06	3.04	4.06	5.28	4.72	4.17	3.67	4.03	5.23	5.46	–
				(7.25)									
1982–2007	10.32	10.81	11.75	10.89		14.53	13.58	11.22	8.22	6.37	5.46	6.37	6.37
Top half	11.69	13.00	14.83	12.34		–	–	–	–	–	–	–	–
Bottom half	8.95	8.62	8.66	9.44		–	–	–	–	–	–	–	–

	Average gain all ages	Average rate all ages
1947–1982	5.93 points	0.170 points per year
Top half	8.63 points	0.247 points per year
Bottom half	3.49 points	0.100 points per year
1982–2007	9.66 points	0.386 points per year
Top half (ages 5.5–7.25)	(12.97 points)	–
Bottom half (ages 5.5–7.25)	(8.92 points)	–
1947–2007	15.59 points	0.260 points per year

wide stratified one based on census data for geographical region, gender, race/ethnicity and parental educational level, a total of 608 children (Raven et al., 2008).

The SPM was also normed three times. The 1938 standardization was done in Ipswich and the 1979 standardization from seven areas designed to give a sample representative of Great Britain as a whole. The 2008 standardization of the SPM PLUS was similar to that of the 2007 Coloured Progressive Matrices. For detail see Flynn (1987) and Raven et al. (2008).

3.2. Data and method

All data are from the standardizations. The norms tables give the number of items correct for percentiles ranging from the 5th to the 95th for the various age groups. All estimates of gains over time were made in Standard Deviation Units (SDUs) and these were multiplied by 15 to convert them into IQ equivalents. The CPM estimates use the S.D. from the various 1982 age distributions. The 1982 distributions provide the best metric because their data is common to all comparisons and they are at the mid-point in time. For the same reason, SPM estimates use the S.D. from the 1979 age distributions.

The primary problem is that while both tests had levels of item difficulty that were originally appropriate, children got better and better at the items over time and the tests became too easy for those at and above the 50th percentile. For example, on the CPM, those who received raw sores of 30 or more items correct (out of 36 items in total) were not properly differentiated for their performance. As Jensen (1980, p. 646) asserts, "some scores above 30 are underestimates of the child's ability, due to the ceiling effect." A ceiling effect also afflicts scores in the top half on the 1979 SPM distributions. For example, by age 9.5 years, the raw score difference between the 95th and 50th percentiles is about half of that between the 50th and 5th percentiles.

Appendix (available on line) gives a series of tables by age for both tests comparing all standardizations. It describes the expedients necessary to get reasonable estimates, both for total gain and gains over the top and bottom halves of the curve, wherever possible. There is a conversion table so that the new SPM PLUS scores can be compared to the old SPM scores. I test the conversion table and find it reliable, and present the 2008 results in a form more convenient than the published source. Finally, there are tables that spell out the implications of the pattern of IQ gains for the nutritional history of Britain in greater detail than is provided in the text.

3.3. The Coloured Progressive Matrices and cohort differences in nutrition

The CPM results shows that between 1947 and 2007, children aged 5.5 to about 11 years gained 15.59 IQ points over those 60 years (Table 1). They gained at a much slower rate between 1947 and 1982 (0.170 points per year) than between 1982 and 2007 (0.386 points). In both cases, gains declined beginning about the age of 9, but recall that it is difficult to allow for ceiling effects when comparing older children.

Note that wherever comparisons are possible, gains among those in the top half of IQ distribution are larger than gains among those in the bottom half. In the 1982–2007 data, this is certainly true of ages 5.5–7.25 years. Since at ages 8 and older no estimates of gains for the two halves are possible, it may be objected that that no firm conclusion about their comparative gains should be stated.

However, the results for 1947–1982 are unambiguous. Taking all ages together, the rate of gain over the top half is 2.5 times that of the bottom half. This directly challenges the nutrition hypothesis. Recall what the latter asserts: that the farther we go into the past, we will find a larger dietary gap between the upper and lower classes; that as time passed, the lower classes made larger nutritional gains than the always reasonably well-fed upper classes; and that therefore, IQ gains should be concentrated in the lower half of the curve.

Here the results are quite the opposite, which would imply that the upper classes made larger dietary gains than the lower classes as we go into the more distant past. Although I am no expert about the history of nutrition in Britain, I believe that such an inference, and worse is to come, sets so difficult a task that no nutritional data is likely to save the nutrition hypothesis.

A caveat: when I talk about how the nutritional gap between the classes must have fluctuated over time, or about how the nutrition of either the upper or lower class must have fluctuated over time, I do not mean to imply that the upper and lower halves of the IQ curve neatly delineate social classes. What happens to the upper half of the curve in terms of IQ trends really sheds light on a group whose members are skewed toward over representation of upper class and better-off middle class Britains; and what happens to the lower half of the curve sheds light on a group skewed toward over representation of lower class and the worse-off middle class. It is the relative difference between the two groups on the class hierarchy that is the operative factor.

Therefore, always assuming that the nutrition hypothesis were true, if the top half of the IQ curve shows large gains between 1947 and the present, we can infer that the diet of the "upper class" in 1947 was much worse than today. If the bottom half of the IQ curve shows modest gains between 1947 and today, then we can infer the diet of the "lower class" was only somewhat worse. And if both of these are true, the nutritional gap between the classes collapses as we go back into the past and therefore, must have been less than it is today. So the nutrition hypothesis is seen to contain a contradiction. The CPM data imply a nutritional history that the nutrition hypothesis itself rejects.

3.4. *The Standard Progressive Matrices and cohort differences in nutrition*

The bottom of Table 2 gives the SPM results. It shows a total gain over the 70 years between 1938 and 2008 of 13.65 IQ points, for a yearly rate of 0.195 points per year. Contrary to the CPM, gains on the SPM appear greater in the earlier period than in the later: between 1938 and 1979 the rate is 0.229 points per year; between 1979 and 2008 it is 0.147 points per year. In both periods, gains declined beginning about the age of 12. At that age and above, the difficulty of allowing for ceiling effects is so profound that the estimates of gains are based on comparisons made at the lower percentiles. These estimates are so small that no plausible gains over the missing part of the distribution would make them good. Therefore, despite the imperfection of the estimates, I conclude that the decline in gains beginning at age 12 is real.

However, the above is deceptive about the comparability of results from the CPM and SPM. As Table 3 shows, when rates of gain are calculated for the ages that all data sets have in common, both the CPM and SPM show higher rates in recent years than earlier years. It is the dramatic drop in gains by children over 11, ages covered by the SPM but not the CPM, in recent years which creates the appearance of a mismatch.

Table 2
Standard Progressive Matrices IQ gains by age in Britain from 1938 to 1979 and 1979 to 2008. Gains over the top half and bottom half of the curve compared where possible.

	Age in years															
	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.5
1938–1979	–	9.69	10.89	10.20	9.33	9.21	11.68	12.08	11.41	9.30	7.87	6.80	6.80	6.80	–	–
Top half	–	9.69	10.21	9.05	7.95	Less	Less	Less	Less	Less	Less	Less	Less	Less	–	–
Bottom half	–	–	–	–	10.71	More	More	More	More	More	More	More	More	More	–	–
1979–2008	11.86	–	10.70	–	8.48	–	6.07	–	1.30	–	2.50	–	1.15	–	−2.24	−1.51
Top half	10.96	–	9.23	–	5.12	–	3.43	–	−.69	–	−.30	–	−2.79	–	−6.29	−5.61
Bottom half	12.76	–	12.17	–	11.83	–	8.70	–	3.29	–	5.30	–	5.09	–	1.82	2.59
							Average gain all ages								Average rate all ages	
1938–1979							9.39 points								0.229 points per year	
Top half							Less								Less	
Bottom half							More								More	
1979–2008							4.26 points								0.147 points per year	
Top half							2.07 points								0.072 points per year	
Bottom half							7.06 points								0.243 points per year	
1938–2008							13.65 points								0.195 points per year	

Table 3
Coloured and Standard Progressive Matrices IQ gains compared over common ages and overlapping periods.

	Average gain ages 7–11	Average rate ages 7–11
CPM 1947–1982	6.56 points	0.187 points per year
CPM 1982–2007	9.58 points	0.382 points per year
	Average gain ages 7.5–11	Average rate ages 7.5–11
SPM 1938–1979	10.50 points	0.256 points per year
SPM 1979–2008	9.28 points	0.320 points per year

Reverting to Table 2, the general pattern of SPM results appear favorable to the nutritional hypothesis. Where the gap between the classes can be measured, it is greater than today (with one exception). The children tested in 1938 were born in the 1920s. Their results also indicate that both upper and lower classes had nutrition that was much worse than today, which may be true.

However, it also implies some surprising things. In stating those implications, I will substitute words for numbers by equating IQ differentials with verbal comparisons. For example, if the mean IQ of the upper half of the curve was one S.D. or more below the mean of the upper half today, I infer that upper class nutrition must have been "massively worse." If the mean was only plus or minus a point or two as compared to today, I infer that the diet then was equivalent to what we enjoy today and label it "adequate" (see Appendix for all equivalents).

Compared to today, upper class children born from 1964 to 1966 had a much better diet than today, and those born from 1967 to 1968 a comparable diet. But in 1969, a radical deterioration set in that took them from worse to hugely worse by 1972. In terms of today, the lower classes had an almost comparable diet in 1965. But in 1966, a radical deterioration set in that took them from much worse to hugely worse for the years 1970–1972. Was there really a radical deterioration in diet from about 1966–1969, which it hit the lower classes first and lasted through 1972?

3.5. Merged results and a dietary history

The analysis thus far is sufficiently disquieting to recommend constructing a dietary history of Britain implied by the total Raven's data (detail in Table A3 of Appendix). The first step is to put all birth cohorts in chronological order and compare the diet of each to that of today (2007–2008). The years over which diet is inferred to have varied are the birth years of cohorts. As Lynn (in press) says: "The nutrition theory posits that the crucial effect of the improvement in nutrition impacts on the fetus and on infants when the brain is growing, and has little subsequent effect." This may be only partially true but nonetheless, cohorts who differ profoundly in the pattern of their IQ gains (and by inference differ profoundly in terms of nutrition) have life spans that differ primarily by birth year. Therefore, to be plausible, the nutrition hypothesis must single out the year of birth as crucial.

Contrary to what the nutrition hypothesis posits, there has been no consistent tendency for the dietary gap between the classes to narrow since 1929. A greater than today gap on the eve of the Great Depression became less than today during the early war years. By the period of 1964–1971, it had expanded to be greater than today. In 1972, it contracted to match today's gap and this trend continued so that in the period of 1975–1977 it became less than today. This last means that the period from 1977 to the present has been a time of growing nutritional inequality. Must Thatcher answer for this?

More disconcerting has been the fate of the classes taken separately. The lower classes were actually worse-off in the 1920s (massively undernourished) than in the Great Depression of the 1930s and the early war years, by which time their lot was ameliorated (to only hugely undernourished). After a brief year or so of adequate diet (by today's standards) in the mid-1960s, they slipped back to a level roughly comparable to the depression/war years and that was still their lot from 1970 to 1974.

The upper half of the classes has been on a roller coaster of change that should have utterly demoralized them. They had a far worse diet than today during end of the Great Depression and the early war years. Then, in the mid-1960s, they went to the other extreme and enjoyed a diet actually much better than they do today. They then began a steady and precipitous slide, one that took them to comparability by 1967 and to a hugely worse diet by the late 1970s. Note that even if there were an objection to using birth dates as the basis of the chronology, any other method would pose much the same problems. For example, if you took the mid-point of the life span of each age group tested, this would merely put the date of a diet hugely worse than today in the early 1980s.

I leave it to British social historians as to whether any large portion of this can be made to fit the facts. Presumably, there were periodic government and academic studies of nutrition over the years. I will only say that my own life in America was much less traumatic. I was born in 1934 into a family that was in upper three-quarters of the class hierarchy. Although my father was unemployed, he was a self-taught journalist by then and friends got him enough piecework so that we never stinted on food. I ate well as a student and have been a professional ever since. I simply cannot recall any radical fluctuation in diet up to this day.

4. An alterative analysis

In my opinion, we need a quite different approach if we are to understand the causes of the IQ gains that occurred in developed nations during the 20th century. The overriding exogenous cause has been the radical industrialization that was underway well before 1900. As to its facets that serve as the ultimate cause of IQ gains over time, the prominent candidates are improved health and nutrition, of course, though mainly in the first half of the century, more and different schooling, smaller family size, modern parenting, the rise of a visual culture, more jobs that requires on-the-spot problem solving, and more leisure, particularly more leisure devoted to cognitively demanding pursuits. Things our predecessors never dreamed of, such as radio, TV, the Internet, and computers occupy our leisure.

4.1. Multiple factors at work

This multiple factor approach goes some of the say to explaining why upheavals such as the Great Depression and World War II did not have a negative impact on IQ gains, for example, US IQ gains look fairly constant all the way from 1932 to 2006. The depression would have worsened nutrition but other factors would have been humming away. During World War II, father absence would have lowered the ratio of adults to children in the home but women expanded their horizons and industrialization proceeded apace.

In most nations, the largest gains occurred on Raven's and the Similarities subtest of the WISC. During the 20th century, society evolved and therefore, set new cognitive problems that made us think differently than we did at its beginning. This new thinking has (like any new activity) led to new habits of mind such as classifying the world in terms of categories without a concrete referent and using logic to deal with abstract concepts. These new activities have influenced the physical organ that pursues them (the brain) just as using a muscle differently affects its development.

In accord with the Dickens/Flynn model, I believe that at any given time, the ultimate causes tend not to be compartmentalized by cohort. Various factors have an initial impact primarily at a certain age, parenting during the pre-school years, school during the school years, peer groups during the later school years, and university and work during the adult years. But thanks to the social interaction of parent and child, older and younger siblings, and so forth, their effects tend to spread throughout all age cohorts at a given time (Dickens and Flynn, 2001a,b).

4.2. Raven's results by time of testing

Therefore, I will present the total Raven's results by time of testing in order to distinguish two eras and isolate differential trends by age. This means merging the Coloured Matrices and the Standard Matrices data within a roughly common time frame. The two earlier periods are 1947–1982 and 1938–1979 respectively, so I will group them as applying to approximately 1943–1980. The two later periods are 1982–2007 and 1979–2008, which become 1980–2008. For each age, I average the CPM results, for example, I average the gains for ages 8 and 8.5 to get a value simply for age 8. Then I average the SPM results in the same way. Finally, after pro-rating them both, I average the two, which gives an overall value for each age. The result is Table 4. As the notes at the bottom of the table make clear, sometimes results are missing, particularly for the top half of the IQ distribution, because ceiling effects made estimates impossible.

Table 4 shows that gains over the upper half of the curve are greater than those over the lower half for ages 5–8, but the reverse is true for ages 9–15. In other words, before the age of 9, the upper classes were making good nutritional deficiencies faster than the lower classes; but after the age of 9, the lower classes made the greater nutritional progress. This seems odd. It is particularly odd that the IQ gains of young upper class children were greater than those of lower class children in the earlier period of 1943–1980. Certainly, the diet pattern must have been precisely the opposite: it must have been the lower classes whose diets improved the most. I can only assume that while diet was a factor, it was weak enough to be swamped by other variables.

4.3. New problems

However, Table 4 also presents problems for my own analysis. One looks for consistency of rate of gain both over age and over class and over time. Where this does not occur, we must look for something that impedes the flow of effects among all members of society. These would have to be institutions and subcultures that are age/class specific and powerful enough to insulate their members against general cognitive trends.

Table 4
Raven's gains by age from 1943 to 2008 (CPM & SPM merged). Gains over top and bottom halves of the curve compared wherever possible.

Age	Rate 1943–1980			Rate 1980–2008			Rate 1943–2008			Average IQ gains		
	Ave	Top	Bot.	Ave	Top	Bot.	Ave	Top	Bot.	1943–1980	1980–2008	1943–2008
5.50	.144	.252	.036	.413	.468	.358	.260	.345	.175	5.33	11.56	16.89
6.25	.101	.188	.013	.451	.557	.346	.252	.347	.156	3.74	12.63	16.37
7.37	.194	.286	.101	.423	.430	.416	.293	.376	.237	7.18	11.84	19.02
8.25	.252	.293	.143	.454	.318	.488	.354	.304	.292	9.32	13.66	22.98
9.25	.206	.208	.200	.335	.177	.402	.262	.195	.287	7.62	9.38	17.00
10.25	.217	.193	.227	.222	.118	.274	.219	.161	.247	8.03	6.22	14.25
11.21	.233	–	.258	.135	−.024	.255	.191	–	.257	8.62	3.78	12.40
12.37	.209	–	.241	.086	−.010	.183	.156	–	.216	7.73	2.41	10.14
13.33	.166	–	.166	.040	−.096	.176	.112	–	.170	6.14	1.12	7.26
14.25	.166	–	.166	−.077	−.217	.063	.061	–	.122	6.14	−2.16	3.98
15.50	–	–	–	−.052	−.193	.089	–	–	–	–	−1.92	–
All	.189	–	.155	.221	.139	.277	.216	–	.216	6.99	6.23	14.03

Notes: (1) See text as to how the CPM and SPM results were merged. (2) Averaging top and bottom will not always give the average for the whole curve. At some ages, all data sets gave results for all of these categories; but at other ages, one or more gave none for at least one category. The blanks designate where either data was missing or was inadequate to give an estimate. (3) Pro-rating the rates for the two periods 1943–1980 and 1980–2008 does not quite give the rate of gain for the whole 65 years—because the latter omits the 15.5-year olds that appear in the second period but not in the first. For the same reason, adding the gains of the two periods is less the total gain for the whole 65 years. If you drop the loss for 15.5 year olds for 1980–2008, you will get the right total. A dummy value for that age of 6.38 gives: 6.93 + 6.23 = 13.16.

In the earlier period of 1943–1980, the average gain for the whole curve behaves quite well over age. For all ages together, the rate of gain is 0.188 IQ points per year and, setting aside one outlier, the rate by age varies only between 0.144 and 0.252. However, why should be upper classes do better than the lower classes before the age of nine and then do worse thereafter? Since nutrition provides no answer, we can only speculate. Perhaps, smaller families and new parenting practices hit the upper classes earlier, favoring their children when young with the advantage fading away as the leveler of school began to bite.

Comparing the two periods, the average rates of gain for the whole curves are quite comparable. When all ages are lumped together, they are 0.189 and 0.221 IQ points per year, respectively. But profound problems are in the offing. In the later period of 1980–2008, we find no constancy. From ages 5 to 8, the average rate of gain for the whole curve is robust around a mean of 0.435 points per year. But then, the rate steadily declines from 0.335 at age 9 down to small losses at ages 14–15. This contrasts with the large gains on Raven's by British adults in the period of 1942–1992 (Flynn, 1998a, Fig. 3). These are larger than any enjoyed by schoolchildren, although one must be guarded as to whether these have continued to the present day.

One hypothesis is that beginning at age 9, gaining in momentum at ages 10–11, and dominating all by ages 12–15, a peer group subculture began to weigh in. In sum, parenting and school became much more cognitively challenging between 1980 and 2008 but peer group subculture was no more cognitively enriched in 2008 than it was in 1980. Fortunately, always assuming that adult gains held up during this period, after their teen-age years, Britons broke out of that subculture as they entered university and the world of work.

The later period also shows relatively equal gains over the top and bottom halves of the curve at ages 5–8 giving way to a much greater gain over the bottom half at age 9 and thereafter. Perhaps, between 1980 and 2008, the peer culture of upper class pre-adolescents and adolescents stagnated in a way that was not so for the lower classes. In other words, upper class peer culture enjoyed an advantage over lower class peer culture in 1980 that had been much eroded by 2008. Could this mean pop culture "corrupted" lower class youth earlier than it did upper class youth? Note that this "corruption" is relative. It is not that peer culture has got worse over time. It is just that the relevant age group has made less cognitive progress over time than those older and younger.

The hypotheses offered are tentative and I do not underestimate the problem of making them precise enough to be subject to falsification. But they illustrate how the data force us to go beyond hypotheses that give pre-eminence to a single factor. I should add that *any* single factor hypothesis will be found wanting. Schooling can no more account for everything than nutrition can.

4.4. The limitations of ultimate factors

A new point: No matter what factors we posit as ultimate causes they would leave us ignorant about proximate causes. Better nutrition may produce better brains, and better schooling better educated people, and smaller families more stimulated toddlers, and so forth. But neither brains nor some abstraction called "better schooled" or "better stimulated" take IQ tests. Minds take IQ tests. Until we have found just what new weaponry minds have got that made IQ test items so much easier, we do not have a full and fecund causal chain.

Quite possibly people could not have developed new habits of thought without formal schooling. It is likely that over the first half of the century better-nourished children got more out of school. But just what did they get? Thinking through the specific items of IQ tests focuses us on that question. At a minimum, they developed new habits of mind that made it natural to classify things rather than differentiate them for utilitarian reasons; and they detached logic from the everyday world to deal with the hypothetical and symbols with no concrete referent. I refer the reader to the examples in Flynn (2009, pp. 23–35).

When faced by a Similarities-type item, what do dogs and rabbits have in common, we say as a matter of course that they are mammals. The person who wears utilitarian rather then scientific spectacles says that you use dogs to hunt rabbits. When given a syllogism about the hypothetical (there are no dogs in Germany; Hamburg is in Germany; are there dogs there?), we are accustomed to detaching logic from the concrete, and say "of course not." The person whose life is grounded in concrete rather than symbolic reality is baffled. Of course, there must be dogs in Germany—who would want or be able to exterminate them all?

In sum, we must identify the exogenous historical cause (technology), the ultimate sociological causes (nutrition, family, schooling, work, leisure), and the proximate psychological causes (new habits of mind). This does not deny brain physiology a role. If you use you muscles for swimming, they develop differently than if you use them for running. If we use our minds differently today than we did in 1900, our brains ought to reflect the difference. An example: Maguire et al. (2000) found that the brains of London taxi-drivers were peculiar. They have an enlarged hippocampus, which is the brain area used for navigating three-dimensional space. They had exercised their brains differently than most of us.

5. Ravens and other tests

A few words regarding both the larger significance and the limitations of our Raven's results. Raven's trends in Britain shed light on a troubling finding about cognitive trends in Britain. But if the impotence of the nutrition hypothesis is to be fully understood, Raven's data must be supplemented by Wechsler data.

5.1. Piagetian tests

Shayer et al. (2007) found that between 1975 and 2003, British schoolchildren aged 14 lost fully 12 IQ points (0.8 S.D.s) on two Piagetian tasks, which involve conceptualizing volume and heaviness. Flynn (2009) noted that British children had also made proportionate losses on the Arithmetic subtest of the WISC, and speculated that the Piagetian losses in question affected specialized skills rather than the general problem-solving ability measured by Raven's. Now Shayer (in press) has done another study on two Piagetian tests of formal operations, namely, Pendulum and Equilibrium in the Balance. The recent samples are from 39 classes in eight schools. IQ scores on various cognitive tests indicate that they were fairly typical, but no stratification variables are presented. Shayer's Tables 1 and 2 show trends since 1976 for British schoolchildren aged 13–14. Taking the tests and the genders together, they gained very little, namely, 0.79 IQ points (0.0525 S.D.s).

This result gains credibility from the SPM data in Table 2. It shows 13.5 year olds gaining 1.15 points between 1979 and the present. The Raven's news is even worse for ages 14.5–15.5, that, is a loss of 1.88 IQ points. The robust IQ gains of young children are not much consolation for Britain if an increasingly universal teen-age culture then erases them. There is, of course, the adult data showing Raven's gains at a rate of fully 0.5 points per year to serve as a source of optimism (Flynn, 1998a, Fig. 3). But unless they are updated beyond 1992, their persistence is in doubt. I look forward, with some trepidation, to what the next century has in store.

5.2. Wechsler subtests

The British Raven's data conveys the message that the nutritional hypothesis cannot confront the pattern of IQ gains in all of its complexity. But to drive this point home, we must leave Raven's whose items are all of the same kind (matrices problems) and briefly look at trends on the Wechsler battery. It has ten subtests ranging all the way from Vocabulary and Arithmetic to using pictures to tell a story and blocks to make a design. Some of these subtests measure what is called fluid intelligence (solving problems on the spot as you do on Raven's) and others measure what is called crystallized intelligence (the sort of knowledge an intelligent person accumulates such as a large vocabulary). Most IQ data show much larger gains on the former than the latter.

Lynn (in press) has attempted to confront that pattern by pointing to the effects of experiments with vitamin supplements, which appear to raise fluid IQ more than crystallized IQ. However, we now know that US adults in America show much more complex trends (Flynn, in press). Between 1953–1954 and 2006, they show large gains on the Vocabulary subtest, which of course measures crystallized intelligence. Moreover, crystallized and fluid subtests are interspersed in terms of the magnitude of gains. To illustrate the point, I will mark subtests with either a C or an F and list them in order of the size of their gains: Similarities (C), Vocabulary (C), Coding (F), Picture Completion (F), Comprehension (C), Picture Arrangement (F), Block Design (F), Information (C), Digit Span (Mixed), Arithmetic (C).

What can nutrition possibly tell us about that hierarchy?

6. Beyond nutrition

Nothing herein denies that diet can benefit cognitive functioning, particularly in terms of delaying cognitive loss with age. Good nutrition helps the entire body and there is some evidence that fish, olive oil, citrus fruits, and vegetables, combined with avoidance of saturated fat, is particularly beneficial to the brain (Melton, 2005).

But diet is not unique in enhancing or sustaining cognitive ability. Cohen (2005) cites evidence that rhythmic use of large muscle groups stimulates the production of chemicals that, in turn, cause primitive brain cells to develop into neurons. It increases the number of connections in the frontal part of the brain, perhaps by increasing the networks of fine blood vessels in those regions. Even vitamins may play a role. In California, an experimental study of the effects of vitamin–mineral supplements on IQ showed that a modest supplement had little effect, a moderate one had significant effect, and a large one little effect (Schoenthaler et al., 1991, pp. 357–358). There is some evidence that that children who are breast-fed have an advantage over those fed a formula (Jensen, 1998).

It is usually better not to retire. Adam et al. (2007) compared performance on a test of episodic memory (among the first of the cognitive abilities that decline with ageing) between two age groups, namely, males aged 50–54 and 60–64, respectively. Obvious confounds were obviated by ranking 12 nations in terms of persistence of employment into old age. The regression line gave striking results. If the percentage of males in work dropped by 90% as men aged (Austria, France), there was a 15% decline in episodic memory. If the percentage in work dropped by 25% (US, Sweden), the decline was only 7%.

All of this may tell us what we should do but that differs from what we have actually done. Today, some may be eating more fish and jogging more, but a lot more are eating so badly that they have created an obesity epidemic. I predict that a dietary history of the US will be no more informative than one for Britain. It will not explain either the large and constant Wechsler Full Scale IQ gains since 1947 or the variation in gains between subtests or the differences between adults and children.

The totality of the evidence supports a summary conclusion. Enhanced nutrition has made us taller people and poor nutrition has made us more obese. But our diet today probably does not make us very different people from our grandparents as far as cognitive competence is concerned. Our brains have altered since 1900, and they are better brains for solving the problems of our time. But they have altered rather like a muscle, that is, they have altered because we use them differently than our parents and grandparents did. The causes of this are many and the effects of nutrition, at least since privation has been banished, are too weak to stand out from the crowd.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ehb.2009.01.009.

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