Fluid intelligence but not vocabulary has increased in Britain, 1979–2008

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ABSTRACT

New standardizations of the Coloured and Standard Progressive Matrices in Britain in 2007 and 2008 show that on the Coloured Progressive Matrices the intelligence of 4 to 11 year olds increased over the years 1982–2007 by 8 IQ points, representing a gain of 3.2 IQ points a decade, and on the Standard Progressive Matrices the intelligence of 7 to 15 year olds increased over the years 1979–2008 by 6.2 IQ points, representing a gain of 1.85 IQ points a decade. IQ gains were greater among those at the low ability level. New standardizations of the Crichton Vocabulary Scale and the Mill Hill Vocabulary Scale in Britain in 2007 and 2008 show a marginal decline on the Crichton Vocabulary Scale among 4 to 11 year olds, and a marginal increase on the Mill Hill Vocabulary Scale among 7 to 15 year olds, suggesting there has been little change in vocabulary over the same time periods. These results are more consistent with the improvements in nutrition theory than with the improvements in education and greater cognitive stimulation theories of the secular gains in intelligence.

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1. Introduction

It has become well established that intelligence has increased in a number of countries during the last 80 years or so. An early study by Tuddenham (1948) reported that the IQ of American conscripts increased by 4.4 IQ points a decade over the years 1917–1943. Subsequent studies confirmed that IQ increases have occurred in the United States, Scotland, England, Japan and several countries in continental Europe (Cattell, 1951; Flynn, 1984, 1987, 2007; Lynn, 1982; Lynn & Hampson, 1986; Lynn, Hampson, & Mullineaux, 1987; Scottish Council for Research in Education, 1949). Most of these IQ increases have been reported in the economically developed nations but IQ increases have also been found in a few economically developing countries including Brazil (Colom, Flores-Mendoza, & Abad, 2007), Dominica (Meisenberg, Lawless, Lambert, & Newton, 2006), Kenya (Daley, Whaley, Sigman, Espinosa, & Neuman, 2003), and Sudan (Khaleefa & Lynn, 2009).

Discussion of these IQ increases has focussed on four principal points. First, have the IQ increases ceased or even gone into reverse in the economically developed nations in the closing decades of the twentieth century and first decade of the twenty-first century? Four recent studies have reported this. These are, first, a study of the intelligence of conscripts in Norway over 50 years has reported that there were the usual gains up to the mid-1990s, but from then until 2002 there has been no increase (Sundet, Barlaug, & Torjussen, 2004). Second, in Australia the IQ of 6–11 year olds measured by the Colored Progressive Matrices has shown no increase from 1975–2003 (Cotton et al., 2005). Third, in Denmark the IQ of young men aged 18–19 conscripted for military service increased between 1959 and 1989 by 3 IQ points per decade, the rate of increase fell to 1.6 IQ points from 1989–1998, peaked in 1998, and declined by 1.6 IQ points from 1988 to 2004 (Teasdale & Owen, 2008). Fourth, in Britain a decline in Piagetian IQ among 11–12 year olds of 12 IQ points over the years 1975–2003, representing a decline of 4.3 IQ points a decade, has been reported by Shayer (2007).

Second: have the increases been greater for fluid IQ (non-verbal & reasoning abilities) than for crystallized intelligence (verbal and educational abilities) and if so, why? Wheeler (1942) appears to be the first to find greater gains in non-verbal than in verbal abilities in a report of the increase in IQs in East Tennessee children aged 6–16 over the years 1930–40. The average gain was considerably greater for non-verbal ability (6.0 IQ points per decade) than for verbal ability (2.6 IQ points per decade).

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This result has been confirmed in many other studies including Flynn (1987, 2007), Lynn and Hampson (1986), and Lynn (1990b).

Third: have the size of increases been the same at all ability levels or greater among lower IQ groups? This question was addressed by Cattell (1951) in his study of the IQ increase in Britain (1936–49) in which he reported that the gain was only present in the lower half of the distribution. In another early study, Elley (1969) reported that IQ gains in New Zealand (1936–68) were smallest in the children of professional parents and greatest in the children of unskilled parents. Other studies finding greater gains among those at lower levels of ability have been reported for Denmark (Teasdale & Owen, 1987, 1989, 2008), Norway (Sundet et al., 2004) and Spain (Colom, Lluis-Font, & Andres-Pueyo, 2005). However, gains have been equally great among those at higher levels of ability in France, the Netherlands and the United States (Flynn, 2007, p.104), while Spitz (1989) has reported that gains in the United States have been greatest at the average IQ level.

Fourth: what factor or factors have been responsible for the IQ increases? Nine principal theories have been advanced. These are (1) Improvement in education has been the most favored theory proposed by Tuddenham (1948), Flynn (1984, 2007), Teasdale and Owen (1994), Flieller (1996, 1999), Greenfield (1998), Jensen (1998), Weede & Kampf (2002), Garlick (2002), Blair, Gamson, Thorne, and Baker (2005), and Meisenberg, Lawless, Lambert, and Newton (2006). (2) Increased test sophistication: Tuddenham (1948), Brand (1987), and Jensen (1998). (3) The greater cognitive stimulation arising from the greater complexity of more recent environments provided by e.g. television, media and computer games: Elley (1969), Jensen (1998), Schooler (1998), Williams (1998), and Sundet et al. (2004). (4) Improvements in child rearing: Elley (1969) and Flieller (1996). (5) More confident test taking attitudes: Brand (1987) and Brand, Freshwater, and Dockrell (1989). (6) The "individual multiplier" and the "social multiplier" (Dickens & Flynn, 2001; Flynn, 2007). (7) Improvements in nutrition: Lynn (1990a, 1993, 1998), Jensen (1998), Colom et al. (2005), and Arija et al. (2006). (8) Heterosis (hybrid vigor) arising from increased out breeding: Jensen (1998) and Mingroni (2004, 2007). (9) Smaller family size (Sundet, Borren, & Tambs, 2008).

In this paper new data are reported bearing on all the issues summarized above. These consist of the secular trend of IQ in Britain for the years 1979–2008 measured by the Coloured Progressive Matrices and the Crichton Vocabulary Scale, and for 1979–2008 measured by the Standard Progressive Matrices and the Mill Hill Vocabulary Scale.

2. Coloured Progressive Matrices

The Coloured Progressive Matrices (CPM) was constructed in the 1940s as a suitable test for children aged 5

Table 2
Raw score gains 1982–2007 on the Coloured Progressive Matrices at percentiles 5 through 95

Percentile	5	25	50	75	95
Gain	3.5	3.2	3.1	2.5	1.6

to 11 years and as an easier version of the Standard Progressive Matrices. The initial standardization of the CPM was carried out in 1949 on 608 children in the small town of Dumfries in Scotland. The test was restandardized in 1982 on a sample of 608 children, again in Dumfries (Raven, Court, & Raven, 1995, p. 56). The 1982 sample showed an increase of 2.7 IQ points a decade over the 33 years 1949–1982 (Lynn & Hampson, 1986).

The test was restandardized again in 2007 on 608 children, but on this occasion the standardization sample included 4 year olds, and the sample was drawn from the whole of the United Kingdom and matched to the population for geographical location and ethnic identity, given in the 2001 census (Rust, 2008a). As in the manuals of previous standardizations, the results of the 2007 restandardization are not given as means and standard deviations but as equivalents of raw scores for each age group. The raw scores at the 50th percentile is an approximate measure of the means for each age group and allow comparison with the previous 1982 standardization sample. This comparison is shown in Table 1. Row 1 gives the ages ranging from 4.5 to 11.5 years. Row 2 gives the median scores of the 1982 sample (including the mean of 4 year olds given by Raven, Court, & Raven, 1977, p.32). Row 3 gives the median scores of the 2008 sample. Row 4 gives the percentiles (PC) of the 2007 sample on the 1982 norms. Thus, the 5.5 year olds in 2007 scored at the 75th percentile of the 1982 standardization sample, etc. It will be seen that at all ages the 2007 sample scored higher than the 1982 standardization sample. The mean of the percentiles of the 2007 sample is 70 and is equivalent to an IQ of 108. Thus the 2007 sample gained 8 IQ points on the 1982 sample, representing a gain of 3.2 IQ points a decade over the 25 years.

To examine the magnitude of the gains at different points of the distribution of intelligence, raw score gains have been calculated for each of the percentiles 5, 25, 50, 75 and 95 (1Qs 75, 90, 100, 110, 125) for which data are given for 1982 and 2007. The raw score gains of the 13 age groups have been averaged and the results are given in Table 2. We see here that the IQ gains have been greatest at the 5th percentile where the raw score gain was 3.5, and the gains decline steadily to less than half (1.6) at the 95th percentile.

3. Standard Progressive Matrices

The Standard Progressive Matrices (SPM) was constructed in the 1930s and first standardized in 1938 on children aged 8 to 14 years (Raven, 1939, 1941). The test was

Table 1
Median scores of the 1982 and 2007 standardization samples on the Coloured Progressive Matrices

Age		4.6	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
1982	Median	12	15	16	17	18	20	22	24	26	28	30	31	31	32
2008	Median	15	18	19	21	24	26	27	28	29	29	30	31	32	33
2008	PC	70	75	75	80	87	83	81	78	75	56	50	50	63	62

Table 3
Median scores of the 1979 and 2008 standardization samples on the Standard Progressive Matrices

Age		7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
1979	Median	22.5	31	35	39	41	42	45.5	45.5	47
2008	Median	30	36	41	43	43.5	44	45.5	45.5	47
2008	PC	77	74	76	73	62	60	50	50	50

Table 4
Raw score gains 1979–2008 on the Standard Progressive Matrices at percentiles 5 through 95

Percentile	5	25	50	75	95
Gain	5	4	3	2	0

restandardized in 1979 on a national sample (Raven, 1981). The 1979 sample showed an increase of 1.86 IQ points a decade over the 41 years 1938–1979 (Lynn & Hampson, 1986).

The test was restandardized again in 2008 on 926 children aged 7 to 18 years on a national sample drawn from the whole of the United Kingdom and matched to the population for geographical location and ethnic identity, given in the 2001 census (Rust, 2008b). This standardization is called the *Standard Progressive Matrices Plus Version* and contains a number of more difficult items than the 1938 and 1979 versions. Scores on the 2008 version cannot therefore be compared with those on the earlier version. This problem can be overcome by using the conversion table provided by Raven, Court, & Raven, 2000, p.78). As in the manuals of previous standardizations, the results of the 2008 restandardization are not given as means and standard deviations but as equivalents of raw scores for each age group. The raw scores at the 50th percentile is an approximate measure of the means for each age group and allow comparison with the previous 1979 standardization sample. This comparison is shown in Table 3. Row 1 gives the ages ranging from 7.5 to 15.5 years (the 1979 standardization covered the age range 6.5 to 15.5). Row 2 gives the median scores of the 1979 sample by Raven (1981). Row 3 gives the 2008 sample's median scores, converted to the 1979 scores. Row 4 gives the percentiles (PC) of the 2008 sample on the 1979 norms. Thus, the 7.5 year olds in 2008 scored at the 77th percentile of the 1979 standardization sample, etc. It will be seen that at ages 7.5 to 12.5 the 2008 sample scored higher than the 1979 standardization sample, but at ages 15.5 through 15.5 the 2008 sample scored the same as the 1979 standardization sample. The mean of the percentiles of the 2008 sample is 63.3 and is equivalent to an IQ of 106.2. Thus the 2008 sample gained 6.2 IQ points on the 1979 sample,

representing a gain of 1.85 IQ points a decade over the 29 years.

To examine the magnitude of the gains at different points of the distribution of intelligence, raw score gains have been calculated for each of the percentiles 5, 25, 50, 75 and 95 (1Qs 75, 90,100, 110, 125) for which data are given for 1979 (Raven, Raven, & Court,1998, p.72) and 2008. The raw score gains of the 9 age groups have been averaged and the results are given in Table 4. We see here that the IQ gains have been greatest at the 5th percentile the raw score gain was 5, and the gains decline steadily to zero at the 95th percentile.

4. The Crichton Vocabulary Scale

The Crichton Vocabulary Scale is a test of the meaning of 80 words, similar to the vocabulary scale in the Wechsler tests. The Scale was constructed in Britain in the 1940s as an easier version of the Mill Hill Vocabulary Scale, suitable for children aged 5 to 11 years. The initial standardization was carried out in 1949 on 608 children in the small town of Dumfries in Scotland. The test was restandardized in 1982 on a sample of 601 children again in Dumfries (Raven, Court, & Raven, 1983). The 1982 sample showed an increase of 2.7 IQ points a decade over the 33 years 1949–1982 (Lynn & Hampson, 1986).

The test was restandardized again in 2007 on 608 children, but on this occasion the standardization sample included 4 year olds, and the sample was drawn from the whole of the United Kingdom and matched to the population for geographical location and ethnic identity, given in the 2001 census (Rust, 2008a,b). The 1982 and 2007 samples were the same as those taking the Coloured Progressive Matrices.

The results of the 2007 restandardization are compared with those of the 1982 restandardization in Table 5. Row 1 gives the ages. Row 2 gives the median scores of the 1982 sample. Row 3 gives the median scores of the 2008 sample. Row 4 gives the percentiles of the 2007 sample on the 1982 norms. Thus, the 5.5 year olds in 2007 scored at the 35th percentile of the 1982 standardization sample, etc. It will be seen that at 5 ages the 2007 scored higher than the 1982 sample, at 2 ages the 2007 sample scored lower than the 1982 sample, and at 3 ages the 2007 sample scored the same as the 1982 sample. The mean of the percentiles of the 2007 sample is 46.7 and is equivalent to an IQ of 97.8. Thus the 2007 sample lost 2.2 IQ points on the 1982 sample, representing a loss of 0.9 IQ points a decade over the 25 years.

To examine the magnitude of the gains at different points of the distribution of intelligence, raw score losses have been calculated for each of the percentiles 5 through

Table 5
Median scores of the 1982 and 2007 standardization samples on the Crichton Vocabulary Scale

Age		4.6	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
1982	Median	–	23	26	29	32	35	38	40	43	45	47	49	52	55
2008	Median	15	19	23	27	32	36	38	40	42	44	46	48	52	56
2008	PC	–	35	36	44	50	53	50	50	47	46	46	46	50	54

Table 6
Raw score losses 1982–2007 on Crichton Vocabulary Scale at percentiles 5 through 95

Percentile	5	25	50	75	95
Loss	−0.6	−0.9	−0.8	−0.5	−0.8

95 for which data are given for 1982 and 2007. The raw score gains and losses of the 13 age groups have been averaged and the results are given in Table 6. We see here that the IQ losses are approximately the same at all of the percentiles.

5. The Mill Hill Vocabulary Scale

The Mill Hill Vocabulary Scale is a test of the meaning of 88 words, similar to the Crichton Vocabulary Scale. The Scale was first standardized in Britain in 1943 on approximately 4500 children in the town of Colchester in England. The test was restandardized in 1979 (Raven, Court, & Raven, 1983). The 1979 sample showed an increase of 0.46 IQ points a decade over the 36 years 1943–1979 (Lynn & Hampson, 1986).

The test was restandardized again in 2008 on 926 children aged 7 to 18 years on a national sample drawn from the whole of the United Kingdom and matched to the population for geographical location and ethnic identity, given in the 2001 census (Rust, 2008b). As in the manuals of previous standardizations, the results of the 2008 restandardization are not given as means and standard deviations but as equivalents of raw scores for each age group. The raw scores at the 50th percentile is an approximate measure of the means for each age group and allow comparison with the previous 1979 standardization sample. This comparison is shown in Table 7. Row 1 gives the ages ranging from 7.5 to 15.5 years (the 1979 standardization covered the age range 6.5 to 15.5). Row 2 gives the median scores of the 1979 sample by Raven (1981, p.48). Row 3 gives the 2008 sample's median scores. Row 4 gives the percentiles (PC) of the 2008 sample on the 1979 norms. Thus, the 7.5 year olds in 2008 obtained the same median score as the 1979 standardization sample, and therefore scored at the 50th percentile of the 1979 standardization sample. It will be seen that at ages 8.5 to 13.5 the 2008 sample scored higher than the 1979 standardization sample, but at ages 14.5 and 15.5 the 2008 sample scored fractionally lower than the 1979 standardization sample. The mean of the percentiles of the 2008 sample is 56 and is equivalent to an IQ of 103.3. Thus the 2008 sample gained 3.3 IQ points on the 1979 sample, representing a gain of 1.1 IQ points a decade over the 29 years.

Table 7
Median scores of the 1979 and 2008 standardization samples on the Mill Hill Vocabulary Scale

Age		7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
1979	Median	15.5	20	24.5	27	30.5	33	36	40	43
2008	Median	15.5	21	26	29.5	31.5	35	37	39	42.5
2008	PC	50	55	64	61	56	65	58	47	48

Table 8
Raw score gains 1979–2008 on the Mill Hill Vocabulary Scale at percentiles 5 through 95

Percentile	5	25	50	75	95
Gain	1.2	0.7	0.9	1.3	−0.9

To examine the magnitude of the gains at different points of the distribution of intelligence, raw score gains have been calculated for each of the percentiles 5, 25, 50, 75 and 95 (1Qs 75, 90,100, 110, 125) for which data are given for 1979 (Raven, Court, & Raven, 1982, p.27) and 2008. The raw score gains of the 9 age groups have been averaged and the results are given in Table 8. We see here that the IQ gains have been about the same at the 5th through 75th percentiles, but at the 95th percentile there was a loss of 0.9 raw scores.

6. Discussion

The results contribute to all of the four issues regarding the increases of intelligence outlined in the introduction.

First: contrary to the results reporting an end of IQ increases in recent years in Norway, Australia, Denmark and Britain noted in the introduction, the data presented here show that fluid intelligence increased over the years 1979 to 2008. In children aged 4–11 years measured by the Colored Progressive Matrices the gain from 1982 to 2007 was 3.2 IQ points a decade and is marginally greater than the gain of 2.7 IQ points a decade over the years 1949–1982 calculated by Lynn and Hampson (1986). A possible explanation for this inconsistency could be that the 1982 sample was below the British average, or that the 2007 sample was above the British average. It may be questioned whether the 1982 sample from the small town of Dumfries in Scotland adequately represented Britain, but it is probably satisfactory because a further sample in south east England tested in the same year obtained virtually identical results (Raven et al., 1995, p. 57). There is no reason to suspect that the 2007 sample was above the British average. In fact, 12.4% of the 2007 sample were ethnic minorities who obtain lower average IQs than indigenous samples (Lynn, 2008), while there were virtually no ethnic minorities in Dumfries in 1982. The effect of this should have been to reduce the scores of the 2007 sample compared with the 1982 sample, in the absence of a secular gain. Both the 1982 and the 2007 samples included slow learners educated in special schools.

Fluid intelligence measured by the Standard Progressive Matrices in children aged 7–15 years also increased over the years 1979 to 2008. The gain was 1.85 IQ points a decade and is remarkably similar to the gain was 1.86 IQ points a decade for the years 1938 to 1979 calculated by Lynn and Hampson (1986).

No explanation can be offered for the inconsistency of the IQ gains on the CPM and SPM in Britain from 1979–2008 and decline of Piagetian IQ in Britain among 11–12 year olds of 12 IQ points over the years 1975–2003 reported by Shayer (2007). It is possible that some abilities may increase over time while others may decline, but this does not seem a likely explanation because the CPM, SPM and Piagetian tests are all largely measures of fluid intelligence (Shayer, Demetriou, & Pervez, 1988).

Second: while fluid IQ measured by the CPM and the SPM increased over the years 1979 to 2008, crystallized intelligence measured by the Crichton Vocabulary Scale registered a loss of 0.9 IQ points a decade (1982–2007) and measured by the Mill Hill Vocabulary Scale registered a gain of 1.1 IQ points a decade (1979–2008). Probably the best reading of these results is to average them leading to the conclusion that there was no change in crystallized intelligence measured by vocabulary in British children during the three decades 1979–2008. Thus, fluid IQ increased over the years 1979 to 2008, while crystallized intelligence remained stable. This result is consistent with numerous previous studies starting from the 1930s (Wheeler, 1942) that have reported greater IQ increases in fluid IQ (non-verbal & reasoning abilities) than in crystallized intelligence (verbal and educational abilities) (Lynn & Hampson, 1986; Flynn, 1987, 2007; Lynn, 1990b).

Third: a number of studies noted in the introduction have reported that the IQ increase been greater among lower IQ groups but there have also been some studies finding that the increases have been the same at all ability levels. The present data confirm the previous studies showing greater IQ increases in the lower range of the ability distribution. On the CPM the gains at the 5th percentile (IQ 75) have been the greatest and the gains have declined steadily to less than half at the 95th percentile (IQ 125) (Table 2). Similarly, on the SPM the gains at the 5th percentile (IQ 75) have been the greatest and the gains declined steadily to zero at the 95th percentile (Table 4). Similarly again, on the Mill Hill Vocabulary Scale there have been IQ gains of about the same magnitude at the 5th through 75th percentiles, but at the 95th percentile (IQ 125) there was an IQ loss (Table 8). However, this trend is not present on Crichton Vocabulary Scale in which marginal losses of approximately equal size where registered at all percentiles (Table 6).

Fourth: what factor or factors have been responsible for the IQ increases? As noted in the introduction, the most commonly advanced theory is the greater cognitive stimulation arising from increases and/or improvements in education and the greater complexity of more recent environments. The data reported here present two problems for the increases and/or improvements in education variant of this theory. First, the theory predicts that there should be no IQ gains in preschool children, a very small gain in children after one or two years of schooling, and progressively increasing gains with age as the cognitively stimulating effect of education has a cumulative effect. The present results do not support this theory and indeed show contrary trends in so far as gains on the CPM have been larger among preschool 4 year olds and among 5–8 year olds than among 9–11 year olds (Table 1). The same trend is present for the SPM where IQ gains have been greatest for 7 year olds and decline steadily with increasing age to 15 year olds (Table 3). On the two vocabulary scales the gains have been greatest among 5 and 6 year olds who have had the least education, and have been about the same over the age range 7–15, and the older children do not register the greater gains predicted from the increases and/or improvement in education theory. These results are not exceptional. A number of previous studies have shown that the gains among pre-school children are just as great, or greater than, those among school-age students. This has been shown in the United States by Thorndike (1977), in

Britain for CPM gains 1949–1882 by Lynn and Hampson (1986), in France for the years 1921–2001 by Bocéréan, Fischer, and Flieller (2003), and even for 1–3 year olds in Australia, Britain and the United States (Lynn, 2009).

Second, the increases and/or improvement in education theory also predicts that IQ gains should be greatest in the cognitive skills that are taught in schools such as vocabulary, and smallest in the cognitive skills that are not taught in schools, such as the novel problems presented in the Progressive Matrices. The present results do not support this theory and again show contrary trends in so far as there has been virtually no gain on vocabulary, while the same samples have shown substantial gains on the Progressive Matrices. This also is not an exceptional result. Numerous previous studies from Wheeler (1942) onwards have reported that gains on crystallized intelligence measured by vocabulary, general knowledge, and arithmetic that are taught in schools have been smaller than gains on fluid intelligence measured by tests like the Progressive Matrices that are not taught in schools.

Other variants of the greater cognitive stimulation theory of the secular increases in intelligence also encounter difficulties from the IQ gain of 4 year olds being as large as that of older children. It is doubtful whether this can be explained by (1) increased test sophistication (Brand, 1987; Jensen, 1998; Tuddenham, 1948); (2) the greater cognitive stimulation arising from the greater complexity of more recent environments provided by e.g. television, media and computer games (Elley, 1969; Jensen, 1998; Schooler, 1998; Sundet et al., 2004; Williams,1998;); (3) more confident test taking attitudes (Brand, 1987; Brand et al., 1989); (4) the "individual multiplier" and the "social multiplier" (Dickens & Flynn, 2001; Flynn, 2007).

The alternative theory that the increase of intelligence has been due to improvements in nutrition advanced by Lynn (1990a,b, 1993, 1998) and endorsed as one causal factor by Arija et al. (2006), Colom et al. (2005), and Jensen (1998, p.325) is better able to explain the large IQ gains of 4 year olds and the larger gains of fluid intelligence than of crystallized intelligence. 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. Hence the IQ gains should be fully present in 4 year olds and should not show increased effects in older children. The improvement in nutrition theory can also explain the greater improvement in fluid than in crystallized intelligence, because numerous studies have shown that fluid ability is more vulnerable to cerebral insult, including sub-optimal nutrition (Lynn, 1990a, 1993, 1998). Hence, as sub-optimal nutrition has declined during the last century, fluid ability has increased more than crystallized ability.

It is possible that other cerebral insults have declined during the last century and contributed to the increases of fluid intelligence. For instance, lead toxicity impairs intelligence and lead exposure has been reduced in many western countries as lead water pipes have been replaced and lead has ceased to be used in paint. The present result showing greater IQ gains among those with lower ability is also predictable from the improvement in nutrition theory, since those at the lower ability levels are more likely to have had sub-optimal nutrition in earlier times and have benefited more from the

improvements in nutrition that have followed rising living standards during the last century. It is doubtful whether any prediction regarding the size of gains at different ability levels can be made from the increases and/or improvement in education theory or other variants of greater cognitive stimulation theory.

Nevertheless, the increases and/or improvement in education theory does provide the most likely explanation for the difference between the IQ gains of school children and the much larger gains of 18 year old military conscripts. The IQ gains of school children reported here have been 3.2 IQ points a decade (1982–2007) on the CPM and 1.85 IQ points a decade (1979–2008) on the SPM, while the gains of 18 year old military conscripts in several countries on the SPM have been around 6 IQ points a decade (Flynn, 1987). The present data compare children who were all at school in the 1979/1982 and in 2007/2008, so an increases and/or improvement in education is an improbable theory for the IQ gains. The 18 year old military conscript data compare earlier cohorts with later cohorts with more schooling. The higher IQs obtained by the later cohorts can be attributed partly to their greater schooling, following the many studies that have shown that education has some effect on intelligence when those with more schooling are compared with those with less (e.g. Husen, 1951; Jencks, 1972; Lorge, 1945).

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