Flynn Effect

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The Flynn effect is the substantial increase in average scores on intelligence tests all over the world. When intelligence quotient (IQ) tests are initially standardized using a standardization sample by convention the average result is set to 100 and the standard deviation of the results is set to 15 points. When IQ tests are revised they are again standardized using a new standardization sample and the average result set to 100. However, if the new sample is tested using older tests in almost every case they score substantially above 100. The effect has been observed in most parts of the world at different rates. Similar improvements have been reported for other cognitions such as semantic and episodic memory.

The effect's increase in the US has been continuous and approximately linear from the earliest years of testing to the present. There are numerous proposed explanations of the Flynn effect and also some skepticism about its implications. The Flynn effect may have ended in at least a few developed nations, possibly allowing the national differences in IQ scores to diminish if the Flynn effects continues in nations with lower average national IQs.

Origin of the term

The Flynn effect is named for James R. Flynn, who did much to document it and promote awareness of its implications. The term itself was coined by the authors of The Bell Curve. J. Philippe Rushton has argued that the effect should be called the "Lynn-Flynn effect", after Richard Lynn, "because it was actually the Lynn (1982) article in Nature that first identified the trend in recent times (among the Japanese)."

The rise in IQ

IQ tests are updated periodically. For example, the Wechsler Intelligence Scale for Children (WISC), originally developed in 1949, was updated in 1974 and 1991. The revised versions are standardized to 100 using new standardization samples. In ordinary use IQ tests are scored with respect to those standardization samples. The only way to compare the difficulty of two versions of a test is to conduct a separate study in which the same subjects take both versions. Doing so confirms IQ gains over time. The average rate of increase seems to be about three IQ points per decade in the US on tests such as the WISC. The increasing raw scores appear on every major test, in every age range and in every modern industrialized country although not necessarily at the same rate as in the US using the WISC. The increase has been continuous and roughly linear from the earliest days of testing to the present. Though the effect is most associated with IQ increases, a similar effect has been found with increases of semantic and episodic memory.

Ulric Neisser estimates that using the IQ values of today the average IQ of the US in 1932, according to the first Stanford-Binet Intelligence Scales standardization sample, was 80. Neisser states that "Hardly any of them would have scored 'very superior,' but nearly one-quarter would

have appeared to be 'deficient.'" He also writes that "Test scores are certainly going up all over the world, but whether intelligence itself has risen remains controversial."

Raven (2000) found that, as Flynn suggested, data interpreted as showing a decrease in many abilities with increasing age must be re-interpreted as showing that there has been a dramatic increase of these abilities with date of birth. On many tests this occurs at all levels of ability.

Some studies have found the gains of the Flynn effect to be particularly concentrated at the lower end of the distribution. Teasdale and Owen (1989), for example, found the effect primarily reduced the number of low-end scores, resulting in an increased number of moderately high scores, with no increase in very high scores. In another study, two large samples of Spanish children were assessed with a 30-year gap. Comparison of the IQ distributions indicated that the mean IQ-scores on the test had increased by 9.7 points (the Flynn effect), the gains were concentrated in the lower half of the distribution and negligible in the top half, and the gains gradually decreased as the IQ of the individuals increased. Some studies have found a reverse Flynn effect with declining scores for those with high IQ.

Flynn originally took the extreme position that the very large increase indicates that IQ tests do not measure intelligence but only a minor sort of "abstract problem-solving ability" with little practical significance. He argued that if IQ gains do reflect intelligence increases, there would have been consequent changes of our society that have not been observed (a presumed non-occurrence of a "cultural renaissance"). Flynn has later changed his arguments as noted in the next section.

The Flynn effect and intelligence models

There are many different kinds of IQ tests using a wide variety of methods. Some tests are visual, some are verbal, some tests only use abstract-reasoning problems, and some tests concentrate on arithmetic, spatial imagery, reading, vocabulary, memory or general knowledge. Early in the 20th century the psychologist Charles Spearman made the first formal factor analysis of correlations between the tests. He found that a single common factor explained for the positive correlations among test. This is an argument still accepted in principle by many psychometricians. Spearman named it g for "general intelligence factor." In any collections of IQ tests, by definition the test that best measures g is the one that has the highest correlations with all the others. Most of these g-loaded tests typically involve some form of abstract reasoning. Therefore Spearman and others have regarded g as the perhaps genetically determined real essence of intelligence. This is still a common but not proven view. Other factor analyses of the data are with different results are possible. Some psychometricians regard g as a statistical artifact. The accepted best measure of g is Raven's Progressive Matrices which is a test of visual reasoning.

Because children attend school longer now and have become much more familiar with the testing

of school-related material, one might expect the greatest gains to occur on such school content-related tests as vocabulary, arithmetic or general information. Just the opposite is the case: abilities such as these have experienced relatively small gains and even occasional decreases over the years. The greatest Flynn effects occur instead for g-loaded tests such as Raven's Progressive Matrices. For example, Dutch conscripts gained 21 points during only 30 years, or 7 points per decade, between 1952 and 1982.

The rise in IQ test scores is not necessarily related to g. Some studies have shown that while scores for subtests have improved over time, the level of improvement is generally uncorrelated with a specific subtest's g-loading (i.e. correlation with g). That is, "The gains in IQ over time (the Lynn-Flynn effect) are unrelated to g". Some that at least part of the Flynn effect was not due to g gains. Others have found gains in g.

Cocodiaa and colleagues (2003) argue that if g was rising this would be seen in eduction. However, in the United States Scholastic Aptitude Test scores may even have declined and employers and teachers worry about diminishing school achievement levels. The authors surveyed primary teachers who had been teaching for 30 years. In Australia they did not report brighter children but in South Korea and Singapore they did. The authors interpret this as that factors such as improved nutrition having increased g in the rapidly developing Asian Nations while g rise in Western nations may have been slow or halted and that non-g factors such as a more visually stimulating environment and increased test taking skills may explain the increasing Western IQ test scores.

Proposed explanations

Attempted explanations have included improved nutrition, a trend toward smaller families, better education, greater environmental complexity, and heterosis (the occurrence of genetically superior offspring from mixing the genes of its parents). Another proposition is the gradual spread of test-taking skills. The Flynn effect has been too rapid for genetic selection to be the cause.

Schooling and test familiarity

Duration of average schooling has increased steadily. One problem with this explanation is that if in the US comparing older and more recent subjects with similar educational levels, then the IQ gains appear almost undiminished in each such group considered individually. Mathematics has been proposed as particularly important.

Many studies find that children who do not attend school score lower on the tests than their regularly attending peers. During the 1960s, when some Virginia counties closed their public schools to avoid racial integration, compensatory private schooling was available only for

Caucasian children. On average, the scores of African-American children who did not receive formal education during that period decreased at a rate of about six IQ points per year.

Another explanation is an increased familiarity of the general population with tests and testing. For example, children who take the very same IQ test a second time usually gain five or six points. However, this seems to set an upper limit on the effects of test sophistication. One problem with this explanation and other related to the schooling is, as noted above, that in the US those subsets one would expect to be affected the most show the least increases.

Another theory is that many parents are now interested in their children's intellectual development and are probably doing more to encourage it than parents did in the past.

Early intervention programs have shown mixed results. Some preschool (ages 3-4) intervention programs like "Head Start" do not produce lasting changes of IQ, although they may confer other benefits. The "Abecedarian Early Intervention Project", an all-day program that provided various forms of environmental enrichment to children from infancy onward, showed IQ gains that did not diminish over time. The IQ difference between the groups, although only five points, was still present at age 12. Not all such projects have been successful. Also, such IQ gains can diminish until age 18. Several other studies have also found lasting cognitive gains.

Generally more stimulating environment

Still another theory is that the general environment today is much more complex and stimulating. One of the most striking 20th century changes of the human intellectual environment has come from the increase of exposure to many types of visual media. From pictures on the wall to movies to television to video games to computers, each successive generation has been exposed to richer optical displays than the one before and may have become more adept at visual analysis. This would explain why tests like the Raven's have shown the greatest increases--they depend on such analysis. This explanation may imply that IQ tests do not necessarily measure a general intelligence factor, especially not Raven's as often argued, but instead may measure different types of intelligence that are developed by different experiences (this argument is against the notion of an underlying general intelligence, or g factor). An increase only of particular form(s) of intelligence would explain why the Flynn effect has not caused a "cultural renaissance too great to be overlooked."

In 2001, Dickens and Flynn presented a model for resolving several contradictory findings regarding IQ. They argue that the measure "heritability" includes both a direct effect of the genotype on IQ and also indirect effects such that the genotype changes the environment, thereby affecting IQ. That is, those with a greater IQ tend to seek stimulating environments that further increase IQ. These reciprocal effects result in gene environment correlation. The direct effect could

initially have been very small but feedback can create large differences of IQ. In their model, an environmental stimulus can have a very great effect on IQ, even for adults, but this effect also decays over time unless the stimulus continues (the model could be adapted to include possible factors, like nutrition during early childhood, that may cause permanent effects). The Flynn effect can be explained by a generally more stimulating environment for all people. The authors suggest that any program designed to increase IQ may produce long-term IQ gains if that program teaches children how to replicate the types of cognitively demanding experiences that produce IQ gains outside the program. To maximize lifetime IQ, the programs should also motivate them to continue searching for cognitively demanding experiences after they have left the program.

Flynn in his 2007 book What Is Intelligence? further expanded on this theory. Environmental changes resulting from modernization -- such as more intellectually demanding work, greater use of technology and smaller families -- have meant that a much larger proportion of people are more accustomed to manipulating abstract concepts such as hypotheses and categories than a century ago. Substantial portions of IQ tests deal with these abilities. Flynn gives, as an example, the question 'What do a dog and a rabbit have in common?' A modern respondent might say they are both mammals (an abstract answer), whereas someone a century ago might have said that humans catch rabbits with dogs (a concrete answer). Citing a high correlation between rising literacy rates and gains in IQ, David Marks has argued that the Flynn effect is caused by changes in literacy rates.

Nutrition

Improved nutrition is another explanation. Today's average adult from an industrialized nation is taller than a comparable adult of a century ago. That increase of stature, likely the result of general improvements of nutrition and health, has been at a rate of more than a centimeter per decade. Available data suggest that these gains have been accompanied by analogous increases of head size, and presumably by an increase of the average size of the brain. This argument has the difficulty that groups who tend to be of smaller overall body size (e.g. women, people of Asian ancestry) do not show lower average IQs. On the other hand nutritional deficiencies such as micronutrient deficiencies often decrease body and organ functionality without affecting volume.

A 2005 study presented data supporting the nutrition hypothesis, which predicts that gains of IQ will occur predominantly at the low end of the distribution where nutritional deprivation is (was) most severe. An alternative interpretation of such uneven distributional gains is that improving educational levels have been particularly important for this group.

Richard Lynn argues that cultural factors cannot typically explain the Flynn effect because its gains are observed even with infant and preschool development and IQ tests at rates of increase about equal to those seen in school students and adults. Lynn argues that "This rules out improvements

in education, greater test sophistication, etc. and most of the other factors that have been proposed to explain the Flynn effect. It is proposed that the most probable factor has been improvements in pre-natal and early post-natal nutrition."

Possibly related to the Flynn effect is change of cranial vault size and shape during the last 150 years in the US. These changes must occur by early childhood because of the early development of the vault. The first two years of life is the critical time for malnutrition, the consequences of which are often irreversible and include poor cognitive development, educability, and future economic productivity.

Infectious diseases

Eppig, Fincher, and Thornhill (2009) argue that "From an energetics standpoint, a developing human will have difficulty building a brain and fighting off infectious diseases at the same time, as both are very metabolically costly tasks" and that "the Flynn effect may be caused in part by the decrease in the intensity of infectious diseases as nations develop." They suggest that improvements in GDP, education, literacy, and nutrition may have an effect on IQ mainly through reducing the intensity of infectious diseases.

Atheendar Venkataramani (2010) studied the effect of malaria on IQ in a sample of Mexicans. Exposure during the birth year to malaria eradication was associated with increases in IQ. It also increased the probability of employment in a skilled occupation. The author suggests that this may be one explanation for the Flynn effect and that this may be an important explanation for the link between national malaria burden and economic development. A literature review of 44 papers states that cognitive abilities and school performance were shown to be impaired in sub-groups of patients (with either cerebral malaria or uncomplicated malaria) when compared with healthy controls. Studies comparing cognitive functions before and after treatment for acute malarial illness continued to show significantly impaired school performance and cognitive abilities even after recovery. Malaria prophylaxis was shown to improve cognitive function and school performance in clinical trials when compared to placebo groups.

Heterosis

Mingroni has argued that the heritability of g is too great to be affected significantly by environmental factors. Mingroni has proposed heterosis (hybrid vigor associated with historical reductions of the levels of inbreeding) as an alternative explanation of the Flynn effect as it pertains to increases of g.

Studies looking at multiple factors

A 2006 study from Brazil examined data from testing children during 1930 and 2002-2004, the largest time gap ever considered. The results are consistent with both the cognitive stimulation and the nutritional hypotheses.

A 2003 study looking at the Flynn effect in Kenya between 1984 and 1998 found that the increase was best explained by parents' literacy, family structure, and children's nutrition and health.

Adjustments due to the Flynn effect

IQ tests need to be adjusted to account for the Flynn effect. The results of comparisons of groups taking IQ tests that differ greatly in age need to be adjusted. Adjusting the scores down if an old test has been used can mean preventing capital punishment since in the United States a diagnosis of mental retardation prevents execution.

Possible end of progression

Jon Martin Sundet and colleagues (2004) examined scores on intelligence tests given to Norwegian conscripts between the 1950s and 2002. They found that the increase of scores of general intelligence stopped after the mid-1990s and declined in numerical reasoning sub-tests.

Teasdale and Owen (2005) examined the results of IQ tests given to Danish male conscripts. Between 1959 and 1979 the gains were 3 points per decade. Between 1979 and 1989 the increase approached 2 IQ points. Between 1989 and 1998 the gain was about 1.3 points. Between 1998 and 2004 IQ declined by about the same amount as it gained between 1989 and 1998. They speculate that "a contributing factor in this recent fall could be a simultaneous decline in proportions of students entering 3-year advanced-level school programs for 16-18 year olds." The same authors in a more comprehensive 2008 study, again on Danish male conscripts, found that there was a 1.5 points increase between 1988 and 1998, but a 1.5 points decrease between 1998 and 2003/2004. A possible contributing factor to the recent decline may be changes in the Danish educational system. Another may the rising proportion of immigrants or their immediate descendants in Denmark. This is supported by data on Danish draftees where first or second generation immigrants with Danish nationality score below average.

In Australia, 6-11 year olds IQ, as measured by the Colored Progressive Matrices, has shown no increase from 1975-2003.

In the United Kingdom, a study by Flynn (2009) found that tests carried out in 1980 and again in 2008 show that the IQ score of an average 14-year-old dropped by more than two points over the period. For the upper half of the results the performance was even worse. Average IQ scores declined by six points. However, children aged between five and 10 saw their IQs increase by up to

half a point a year over the three decades. Flynn argues that the abnormal drop in British teenage IQ could be due to youth culture having "stagnated" or even dumbed down. He also states that the youth culture is more oriented towards computer games than towards of reading and holding conversations. Researcher Richard House, commenting on the study, also mentions the computer culture diminishing reading books as well as a tendency towards teaching to the test.

Lynn and Harvey have argued that the causes of the above are difficult to interpret since these countries have had significant recent immigration from countries with lower average national IQs. Nevertheless, they expect similar patterns to occur, or have occurred, first in other developed nations and then in the developing world as there is a limit to how much environmental factors can improve intelligence. Furthermore, during the last century there is a negative correlation between fertility and intelligence. They estimate that there has been a dysgenic decline in the world's genotypic IQ (masked by the Flynn effect for the phenotype) of 0.86 IQ points for the years 1950-2000. A further decline of 1.28 IQ points in the world's genotypic IQ is projected for the years 2000-2050. Similarly but looking at phenotypic IQ, Meisenberg has argued that both higher GDP and IQ independently reduce fertility. The study argues that "at present rates of fertility and mortality and in the absence of changes within countries, the average IQ of the young world population would decline by 1.34 points per decade and the average per capita income would decline by 0.79% per year."

If there have been declines in national IQs this may have causes other than those proposed above. Researchers have warned that constantly greater exposure to industrial chemicals proven to damage the nervous system, especially in children, in industrialized nations may be responsible for a "silent pandemic" of brain development disorders.

The Flynn effect and IQ group differences

If the Flynn effect have ended in developed nations, then this may possibly allow national differences in IQ scores to diminish if the Flynn effect continues in nations with lower average national IQs.

Also, if the Flynn effect has ended for the majority in developed nations, it may still continue for minorities, especially for groups like immigrants where many may have received poor nutrition during early childhood or have had other disadvantages. A study in the Netherlands found that children to non-Western immigrants had improvements for g, educational achievements, and work proficiency compared to their parents although there were still remaining differences to ethnic Dutch.

There is a controversy regarding whether the US racial gap in IQ scores is converging. If that is the case then this may or may not be related to the Flynn effect. Rushton and Jensen argue against

expecting the Flynn Effect to narrow the US black-white IQ gap since they see that gap as mostly genetic in origin and there is evidence from mathematical analyses that what causes the Flynn effect is different from what causes the black-white gap. Flynn has replied that he never claimed that the Flynn effect has the same causes as the black-white gap but that it shows that environmental factors can create IQ differences of a magnitude similar to the gap. The Flynn effect has also been part of the discussions regarding Spearman's hypothesis.