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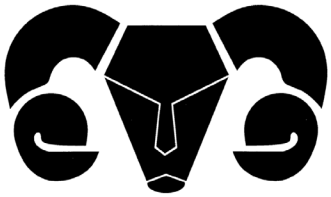

The Flynn Effect in Rural Kenya

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Multiple studies have documented significant IQ gains over time, labeled the "Flynn Effect". Data available from 20 industrialized nations show massive IQ gains over time, most notably in culturally reduced tests like the Raven's Progressive Matrices that are believed to be the purest measures of intelligence (Flynn, 1987, 1999). To our knowledge, this is the first study to document the Flynn Effect in a rural area of a developing country. Data for this project were collected as part of two large studies in Embu, Kenya in 1984 and 1998. Results strongly support a Flynn Effect over this 14-year period, with the most significant gains found in the Raven's. Previously hypothesized explanations (e.g. improved nutrition, increased environmental complexity, family, parental, school and methodological factors) for the Flynn Effect are evaluated for their potential relevance in this community.

Background

Significant gains in IQ over time, dubbed the "Flynn Effect," have been documented in twenty industrialized nations. These gains are most notable in tests that are often believed to be culturally reduced, like the Raven's Progressive Matrices, although a rise in scores has also been observed in tests of crystallized intelligence such as the Weschler (Flynn, 1987, 1999; Neisser, 1998).

One prominent explanation for the Flynn Effect points to nutrition (Lynn, 1998). Better nutrition is hypothesized to impact brain function. Multiple indicators of nutritional status, including caloric intake, height and weight, are indeed associated with improved cognitive performance (eg. Espinosa, Sigman, Neumann, Bwibo & McDonald, 1992). Other previously hypothesized explanations for the Flynn Effect include increased environmental complexity that affects cognitive flexibility (Schooler, 1998; Williams, 1998), family structure (Downey, 2001), parental migration from rural to urban areas that impacts parental attitudes and input to children (Flynn, 1998; Schooler, 1998), school quality and attendance (Teasdale & Owen, 1989), and methodological explanations that suggest the Flynn Effect may in part be an artifact of testing (Williams, 1998; Brand, 1987).

The current study examines the Flynn Effect among children in a rural area of a developing country over a 14 year period and evaluates the fit of previous hypotheses and other possibilities that may contribute to a rise in measured IQ in this community.

Measures and Data Analysis

This study was located in Embu District of Kenya. Data for this study were collected in 1984 as part of the Nutrition Collaborative Research Support Program (CRSP) and in 1998 as part of the Child Nutrition Project (CNP) of the GL-CRSP.. The 1984 sample (Cohort 1) is composed of 120 children (Mean age=7.43 years, SD=.46), and the 1998 sample (Cohort 2) consists of 514 children, (M=7.32 years, SD=1.0). The two cohorts did not differ reliably in mean age or gender composition.

The cognitive battery included three identical measures at both time points: the Ravens Colored Progressive Matrices (Raven, 1965), the Verbal Meaning Test (similar to the Peabody Picture Vocabulary Test; Dunn & Dunn, 1981), but with culturally appropriate pictures developed with samples of urban children in East Africa, and the Digit Span test, which requires the child to repeat a series of digits after the experimenter has said them. Other measures included food intake, information on child health (anemia, hookworm and ascaris) at both time points, and demographic information such as parent age and marital status, the composition of the household and age of each member, parent time away from the household, and parent years of schooling. Parent literacy was also assessed with a series of eleven passages extracted from the English Reading Textbooks from Standard One through Form Four (roughly first through eleventh grade). Reliability for all measures was excellent.

Results and Conclusions

T-tests were used to compare children in Cohort 1 and Cohort 2 on the three cognitive measures described above.

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The Flynn Effect clearly emerged, as there were significant increases on all three child cognitive measures (see Table 1 for means and standard deviations). The Raven's Progressive Matrices increase of 5 points over a 14-year period is consistent with findings from industrialized countries. The increase on all three measures suggests changes beyond just fluid intelligence.

Table 1. The Flynn Effect: Raw Scores of Rural Kenyan School Children

	1984 Study (N=120)	1998 Study (N=514)
Cognitive Tests, Mean (SD)		
Raven's	12.68 (3.4)	17.30 (2.5)***
Verbal Meaning	24.3 (6.6)	27.0 (4.8)***
Digit Span	4.58 (2.3)	5.02 (1.8)*

**p<.05, ***p<.0001 using 2 tailed significance tests.*

Potential Explanatory Factors

Nutrition: Analyses of kilocalories (kcals) and animal protein demonstrate differences in the diets of children in 1998 as compared to 1984. Specifically, children in 1998 had significantly more kcals, $t(633) = 5.26$, $p<.0001$ and protein, $t(633) = 5.80$, $p < .0001$ than children in 1984. No differences were seen in animal source protein or Vitamin B_{12}.

Environmental complexity: Data to support this hypothesis are limited; prefabricated toys and games, fast food placemats, and cereal boxes were scarcely seen among the 1998 cohort. Data are not available from 1984, but in 1998 9% of household owned a TV and 66% of parents reported reading a newspaper or magazine at least once a week.

Family factors: SES, family size and family structure: Despite the population rise in Kenya over this period, family size significantly declined from an average of 9.2 household members in 1984 to 6.7 in 1998, $t(612) = -7.39$, $p<.0001$. If as a result of this decrease in family size families were able to spend more money on each child in the family, the 1998 sample may be leading a more comfortable life.

Changes in family structure also occurred during this fourteen-year period. In 1984, only about 4% of the fathers were away from home for more than two thirds of the year. By 1998, this figure doubled, with many fathers seeking employment in Nairobi. In addition, a dramatic shift in mother's marital status occurred during these 14 years. Whereas 100% of the mothers reported being married or cohabitating in 1984, this figure dropped to 82% of the 1998 mothers, $\chi^2(4, N= 579) = 23.17$, $p<.0001$.

Parental factors: Education and literacy: There was a clear rise in the report of parental education and literacy. In 1984, 26% of the mothers reported no schooling at all, and only 6.8% reported more than an 8th Grade education. In contrast, in 1998, only 8.7% of mothers reported no schooling, and 17.5% reported more than an 8th Grade education, $\chi^2(5, N = 565)=33.05$, $p<.0001$. Fathers in 1984 received more education than mothers at that time, and fathers in 1998 clearly attained higher levels than fathers in the 1984 sample, $\chi^2(5, N = 485)=21.07$, $p<.001$.

Consistent with this increase in reported parental education, literacy testing revealed differences in level of fluency in reading and writing. In this fourteen year period, mother's reading ability increased from a 4th Standard to almost 7th Standard, t (215)

Table 2. Anthropometry, Nutrition and Health Variables

Variable	1984 Study (N=120)†	1998 Study (N=514)†
Food Intake		
Energy (kcal)	1506 (290)	1762 (493)***
Protein (g)	43.5 (10.9)	53.6 (17.5)***
Health status		
Hemoglobin level	12.34 (1.08)	11.24 (1.82)***
Normal hemoglobin	90%	60.9%
Mild hemoglobin deficiency	10%	26.9%
Mod. hemoglobin deficiency	0%	9.0%
Severe hemoglobin deficiency	0%	3.1%
Hookworm	33%	2.0%
Ascaris	3.8%	1.9%

† Number of participants in each study, actual N for each analysis varied depending on missing data.
****p<.0001*

= 4.82, p<.0001, and writing scores increased from a 4th Standard to a 5th Standard, t (197) = 2.4, p=.018.

School factors: Children in both cohorts attended school and were tested just four months after starting their first year. School attendance itself therefore is unlikely to be related to achievement in these samples. Although we are unable to quantify an improvement in school quality, fieldworkers who have resided in Embu during both time periods cite improvements in school infrastructure and the number of trained teachers in the schools as important differences in their community.

Methodological factors: Given that the Raven's, Verbal Meaning, and Digit Span tests are unlike Kenyan standardized exams and unfamiliar to Embu teachers, it is unlikely that children are being taught to the test. In this study, identical versions of the test were used and children were tested under the same conditions, during the same months (June-August) in both samples, which occurred four months into the beginning of their first year of formal schooling. Moreover, half the cognitive testers were the same at both time points and all were trained by the same supervisor. The methodological rigor of the current Flynn Effect is especially compelling, given the virtually identical testing conditions.

Health Status: We found that hemoglobin counts, an indicator of anemia, showed significantly worse health status over this time period, t(597) = -7.92, p<.0001. However, while anemia was more severe in 1998, it was less prevalent; using a cutoff of 11 gm/dl, about 50% of Cohort 1 children were found to be anemic, as compared to 37.2% of Cohort 2. Comparisons of intestinal parasites suggest that 6.2% of the 1984 sample had ascaris ova in their stool, compared to 1.9% of the 1998 sample. Hookworm infestation was considerably less in 1998 (2% of participants) than in 1984 (36.4% of participants).

Practical Implications

The hypotheses that resonate best with our findings are those related to parent literacy, family structure, and child nutrition and health. As reported, maternal education increased during this period. In addition, a shift in family structure shows that mothers are more likely to be unmarried. Perhaps these more educated and independent mothers recognize a strategic advantage gained through education, and therefore, may emphasize school-related skills to their children through everyday socialization practices.

This explanation is consistent with Buchmann's (2000) finding that rural Kenyan parents who held the belief that children had an obligation to provide financial help to them in the future were more likely to send their children to school. Thus, a shift in values toward an emphasis on schooling may have occurred during this time period as a result of a combination of increased parental education, and emphasis on schooling and school-related skills and knowledge. This explanation, though not wholly satisfactory, appears more plausible than others, such as the contribution of environmental complexity in rural Kenya. Changes in children's nutrition and health may have also contributed to increased cognitive scores. Over this 14-year period, a significant increase in energy and protein intake was also observed, suggesting children in 1998 have both more food and higher quality food available. Nutritional improvement is a likely contributor to the rise in cognitive performance observed in this population. Nutrition alone, however, is unlikely to account for the significant gains evidenced in IQ scores. Better-fed individuals can learn and perform better only if they have access to experiences that shape their development appropriately for the demands of their culture (Sigman & Whaley, 1998).

The many children infested with hookworm in 1984 may have been iron deficient, which is associated with decreased cognitive abilities (see Granthan-McGregor & Ani, 2001 for a recent review of this issue), even in the absence of anemia (e.g. Halterman, Kaczorowski, Aligne, Auinger, & Szilagyi, 2001). Thus, the information on health status in this population can provide an avenue of inquiry that has not been systematically examined in research on the Flynn Effect.

Our study is the first we are aware of to examine the Flynn Effect in a rural population of a developing country. We have presented preliminary evidence, using the most directly comparable data available to us, of each of the previously hypothesized causal factors of phenomenon. Our analyses shift attention away from the environmental complexity hypothesis and toward the role of nutrition, parent education, and child socialization. We hope researchers will take up the challenge to isolate social and economic contributions to the Flynn Effect in other rural communities.

Further Readings

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The GL-CRSP Child Nutrition Project (CNP) was established in 1997 and is built on a decade of research conducted by the Nutrition CRSP (USAID) in the 1980s. The Child Nutrition Project research addresses food-based approaches to micronutrient deficiencies, particularly of children with respect to both the quantity and quality of food intake. The study is centered on a controlled intervention feeding trial of school children in Embu, Kenya. The project is directed by Dr. Charlotte Neumann and Professor Nimrod Bwibo as Principal Investigators and Suzanne Murphy, Marion Sigman, Shannon Whaley, and Lindsay Allen as Co-Investigators. Email contact for Dr. C. Neumann is: cneumann@ucla.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East Africa, Central Asia and Latin America.

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