The Family Dynamics of Intellectual Development

R. B. Zajonc
Stanford University

Birth order effects on intellectual performance show both positive and negative results. The confluence model reconciles these conflicting data by proving that these effects interact with the age of participants at testing, such that young children should show negative or no effects, whereas older individuals (past age 11 ±2 years) should show positive effects. Birth order studies strongly support this prediction. Some writers have claimed the apparent relation between birth order and intelligence is an artifact created by applying a cross-sectional analysis to data that should have been analyzed by comparing siblings within families. However, if siblings within the same family are compared all at the same time, their ages are necessarily different. As a result, birth order effects are confounded with age effects. Moreover, within-family data conceal patterns of aggregate effects that cross-sectional data reveal.

Researchers' beliefs about the effects of family factors, such as relationships among siblings, the ages of parents, and especially birth rank and family size, range from an indisputable certainty (e.g., Breland, 1974; Eysenck & Cookson, 1970; Sulloway, 1996) to a complete denial (Rodgers, Cleveland, van den Oord, & Rowe, 2000; Schooler, 1972) that these factors influence intellectual and scholastic performance. Yet, for millennia, diverse societies and cultures have placed a great deal of faith in these family factors as predictors of positive outcomes. Birth rank is regarded as a proxy of promise, potential, and actual ability. Firstborn children, especially boys, are slated to assume responsibility for a family's fortunes, are preferred as leaders, are selected for important positions, are entrusted with power, are accorded primacy in succession to a family's assets, and are expected to assume major responsibility for aging parents (Sulloway, 1996). In Bali, children are given names according to their birth order: *Wayan* for the firstborn, *Madé* for the second, *Nyoman* for the third, and *Ktut* for the fourth. A look at a drawer of family photographs will reveal an overrepresentation of the firstborn.

When considering the intellectual development of children within the family, it is clear that each successive child enters into a different environment and begins a particular cycle of growth. At the same time, each successive child changes and keeps on changing the family environment. Diverse aspects of the family environment—social, economic, intellectual—that greet successive siblings must affect growing children in somewhat different ways. In this article, I consider only the intellectual aspects of siblings' changing environments. Thus, first children have their parents all to themselves. For parents, this is novel and absorbing. Life will never be the same for them. Joy, pride, concern, anxiety, and fulfillment dominate parents' dispositions, and all reactions to first infants' behaviors carry an element of uncertainty and require constant adaptation.

On the birth of a second child, experience makes caregiving easier and allows parents to be a lot calmer. Of course, two children are more demanding of parents' time and care than one child is. Parents make adjustments, which are accompanied by concern that the firstborn should not be neglected, that jealousies should not develop, and that the siblings should grow free of conflict. In different families, successive children follow these patterns to a greater or lesser extent.

These differences within each family's environment are revealed in the personality, occupational, and intellectual development of successive children. The trajectory of children's intellectual development is especially complex, and its effects are subtle. Looking at children's periods of growth, I start with firstborn children who—until there is another birth—are families' only objects of care. I limit myself here to just one aspect of the intellectual environment that might affect children's intellectual growth—the pool of words, or the lexical surround. If researchers were to register all the words and utterances to which newborns are exposed, and if they could measure the diversity, the sophistication, the use of metaphors and analogies, and the exercise of precision in expression, they might be able to capture the quality of the lexical surround to which children are exposed on a daily basis.

Firstborn children, until the birth of younger siblings, are exposed only to adult language. If no other siblings enter the family, only children will continue in this fairly

---

This work was supported by National Science Foundation Grant SBR 9726886. I am grateful to Hazel Markus and Ian Gotlib for their very useful suggestions.

Correspondence concerning this article should be addressed to R. B. Zajonc, Department of Psychology, Jordan Hall, Stanford University, Stanford, CA 94305. Electronic mail may be sent to zajonc@psych.stanford.edu.

Vol. 56, No. 6/7, 490–496 DOI: 10.1037//0003-066X.56.6-7.490

unchanging environment until they achieve full mental maturity, but the story is different for second-born children. Second children are exposed not only to the verbal output of the parents but to the vocalizations of older siblings and, if there is a substantial gap between the two births, to the verbal output of older siblings. Depending on the mental maturity of the older siblings, this lexical surround may be more or less mature. If a sibling is five years older, a different pool of words will characterize the environment than when a sibling is only one year older. This differential exposure may well manifest itself later in younger children's performance on tests of verbal fluency, vocabulary, and comprehension.

As the children mature, important features of the interactions among them emerge. Very often older siblings are called on, either by younger siblings or by parents, to act as parent surrogates. Second-born children might ask older siblings about the meanings of words, about how some things work and why, about the whereabouts of candy or of a parent who is late in coming back home, and about countless other matters that older siblings must now explain. When second-born children reach a level of maturity allowing them to ask these questions, then firstborn children's lives change quite dramatically—they become tutors. In this role of tutor, firstborn children gain an intellectual advantage. By virtue of rehearsal, by virtue of having to articulate an explanation or offer the meaning of a word, firstborns gain more verbal fluency more quickly than the second-borns. However, younger siblings, if they are the last children in their families, will never act as tutors and thus are intellectually disadvantaged in comparison to older siblings. Last siblings are therefore in the same situation as are only children because neither group is offered the opportunity to be a tutor.

These dynamics of the intellectual development of siblings within families were quantified in the *confluence model* (Zajonc, 1976), so named because the mental maturities of children growing up in the same families flow together over time in their influence on each other, changing constantly over time and changing most profoundly when new offspring join the sibship or some family members leave. All family members contribute to the quality of the intellectual environment. The confluence model focuses mainly on intellectual influences, reflected in the measurable mental ages of individual family members. Although the developmental process within the family encompasses many other changes, other consequences (such as social efficacy or assertiveness) are not subject to analysis by the confluence model. This is so because the model can be tested only with reliable measurements of developmental outcomes of large populations, and among those, academic and intellectual performance offer such data sets.

The following simplified example illustrates the computation of predictions from the confluence model. The intellectual environment is quantified by assigning some numerical value, say in mental age units, to each person within the family. For instance, a value of 30 may be assigned to each of the parents and 0 to the newborn child, for an average of $(30 + 30 + 0)/3 = 20$. If a second child is born into the family when the firstborn is four years old, the average would be $(30 + 30 + 4 + 0)/4 = 16$. Say that after a lapse of three years, there is a third offspring. The average value is reduced further: $(30 + 30 + 7 + 3 + 0)/5 = 14$. Thus, each successive sibling is born into a weaker intellectual environment. Whereas at birth the intellectual environment of the firstborn surpasses that of the second born, things change very rapidly. It is important to note that when both children in the example above are tested at eight years of age, the averages are $(30 + 30 + 8 + 4)/4 = 18$ for the firstborn and $(30 + 30 + 12 + 8)/4 = 20$ for the second born. The second born benefits from a better environment because the later-born child has an older sibling, whereas at the same age of testing, the firstborn has a less mature sibling, a configuration that reverses the birth order effect at that age.

However, in addition to the overall intellectual environment, designated as α, that is illustrated by the above example, the confluence model implicates another important factor, the teaching function, designated as λ. This factor describes the benefits that accrue to older siblings from being tutors. Two or three years after firstborns gain a sibling, they can begin to assume tutorial functions—functions that benefit the tutor as much as the tutee. The two terms of the confluence equation contribute differentially to the growth of intellectual maturity, α negatively and λ positively, and the quality of the intellectual environment is simply the sum of α and λ at each given age. As the number of siblings increases, the intellectual environment in the family declines in its relative quality. The teaching function, however, whereby the older children serve as tutors to the younger ones, mitigates the negative effects of the expanding family. If a family has only two children, the firstborn will be the only one to benefit from a teaching function, λ, that reaches equality with the level of intellectual environment, α, at age 11 ±2 years. Note that last children (and, of course, all children are last for some period of time) do not benefit from the teaching function. Hence, the only child, who has no one to teach, is predicted to score at a lower level than the firstborn of two, a prediction confirmed repeatedly in a variety of data sets. This simplified example dramatizes the crucial importance of the age of testing in evaluating birth order and family size effects.

Birth Order and Family Size Effects Depend Crucially on the Age at Which Children Are Tested

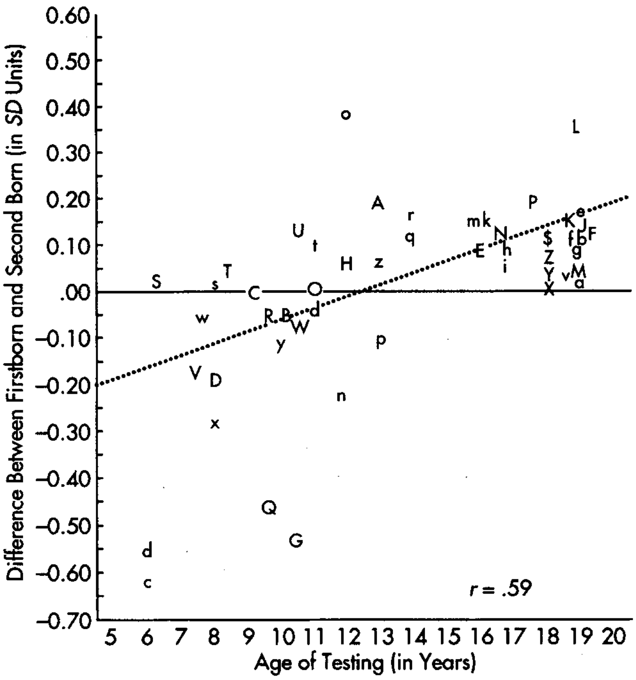
Because some data reveal a positive relationship between birth order and test scores and other data reveal a negative or null relationship, many researchers have been led to conclude that no systematic effects on intellectual and academic performance should be expected from variations in birth order. Rodgers, Cleveland, van den Oord, and Rowe (2000), for example, claimed that "the apparent relation between birth order and intelligence has been a methodological illusion" (p. 599). The illusion has been created, according to Rodgers et al., by applying a cross-sectional analysis to data that should have been analyzed by comparing siblings within families. However, these seemingly contradictory results are in fact what would be expected from the confluence model, which, as was shown above, predicts birth order effects on intelligence to be age specific. When children are tested before age 11 ±2 years, the model predicts negative or no differences in intellectual level as a function of birth order and predicts a positive effect for individuals tested at more mature ages. The explanation is straightforward. The accumulations of the negative contributions of a growing α and the accumulations of the positive effects of λ have different trajectories. The benefits of teaching do not start at birth and at first grow less rapidly than the disadvantages of increasing sibships. The confluence model, therefore, predicts a negative influence or no influence of birth order (lower scores for high birth ranks) for ages less than 11 ±2 years and a positive influence of birth order (higher scores for high ranks) for children older than 11 ±2 years. These predictions have been confirmed by a large variety of data sets (Zajonc, 1983, pp. 475–480; Zajonc & Bargh, 1980b, p. 360; Zajonc, Markus, & Markus, 1979, pp. 1328–1338; Zajonc & Mullally, 1997, pp. 690–692), and this research has allowed psychologists to understand what appeared to be conflicting data on birth order, with some data showing a positive relation and others a negative relation to measured intellectual performance.

Figure 1 illustrates this vulnerability of birth order effects to the age of testing (Zajonc, 1983, pp. 476–477). For all the published studies of birth order in which there were data on intellectual or academic performance for two-child families and for which there was information about the age of the participants, differences in standard scores between firstborn and second-born children were calculated. These differences were then plotted against the age of testing. Figure 1 shows the plot of 50 studies, yielding a correlation of .59. Note that none of the data sets of children over 13 years old show a negative birth order effect. Thus, the confluence model does indeed predict both positive and negative birth order effects. It extracts from what some authors have regarded as random variation a systematic and theoretically justified explanation.

Rodgers et al. (2000) recently asked whether "large families cause low-IQ children, or [whether] low-IQ parents make large families" (p. 603). Their answer drew on the patterns of birth order effects. According to Rodgers et al., if large families "caused" low-IQ children, "declines in IQ across birth order" (p. 603) would be expected, and they stated that "if low-IQ parents are having large families, we would expect (statistically) flat patterns across birth order" (p. 603). Because Rodgers et al. found their data to be flat across birth order, they took it as proven not that large families "cause low-IQ children" but instead that low-IQ parents tend to have large families. After noting that birth order effects are age specific, Rodgers et al. nevertheless supported their claim with data for populations right at the crossover age or younger, the age where the two terms of the confluence process cancel each other out. If plotted in Figure 1, their data would be among those below the zero

Figure 1

Differences in Standard Scores Between First- and Second-Born Children as a Function of the Age of Children at Testing



Note. Lower- and uppercase letters refer to data from the following studies: a = Altus (1965, male participants); b = Altus (1965, female participants); c = Arthur (1926, Sample 2); d = Arthur (1926, Sample 1); e = Belmont and Marolla (1973, nonmanual condition); f = Belmont and Marolla (1973, manual condition); g = Belmont and Marolla (1973, farm group); h = Breland (1974, male participants); j = Breland (1974, female participants); k = Burton (1968, male participants); m = Burton (1968, female participants); n = Cicirelli (1977, male participants); o = Cicirelli (1977, female participants); p = Claudy (1976); q = Davis, Cahan, and Bashi (1977, western Israelis); r = Davis, Cahan, and Bashi (1977, Asian Israelis); s = Douglas (1964, 8-year-olds); t = Douglas (1964, 11-year-olds); u = Eysenck and Cookson (1970); v = Galbraith (1982); w = Hsiao (1931, 7.5-year-olds); x = Hsiao (1931, 8-year-olds); y = Hsiao (1931, 10-year-olds); z = Hsiao (1931, Sample 1, 13-year-olds); A = Hsiao (1931, Sample 2, 13-year-olds); B = Institut National d'Etudes Démographiques (1973); C = Jensen (personal communication, December 12, 1979); D = Koch (1954); E = Kunz and Peterson (1977); F = Page and Grandon (1979); G = Richardson (1936, spacing of 3.6 years); H = Richardson (1936, spacing of less than 1 year); J = Rosenberg and Sutton-Smith (1969, male participants, large spacing); K = Rosenberg and Sutton-Smith (1969, female participants, large spacing); L = Rosenberg and Sutton-Smith (1969, male participants, short spacing); M = Rosenberg and Sutton-Smith (1969, female participants, short spacing); N = Schachter (1963); O = Scottish Council for Research on Education (1949); P = Steckel (1930); Q = Steelman and Mercy (1980, below poverty level); R = Steelman and Mercy (1980, above poverty level); S = Svanum and Bringle (1980, 6- to 7-year-olds); T = Svanum and Bringle (1980, 8- to 9-year-olds); U = Svanum and Bringle (1980, 10- to 11-year-olds); V = Tabah and Sutter (1954, 6- to 9-year-olds); W = Tabah and Sutter (1954, 9- to 12-year-olds); X = Velandia, Grandon, and Page (1978); Y = Zajonc and Bargh (1980a, 1970–1971 cohort); Z = Zajonc and Bargh (1980a, 1973–1974 cohort); $ = Zajonc and Bargh (1980a, 1976–1977 cohort).

line. Rodgers et al. acknowledged the absence from their analysis of data for populations above the crossover age merely as a "slight weakness" (p. 610). It is in fact a fatal flaw.

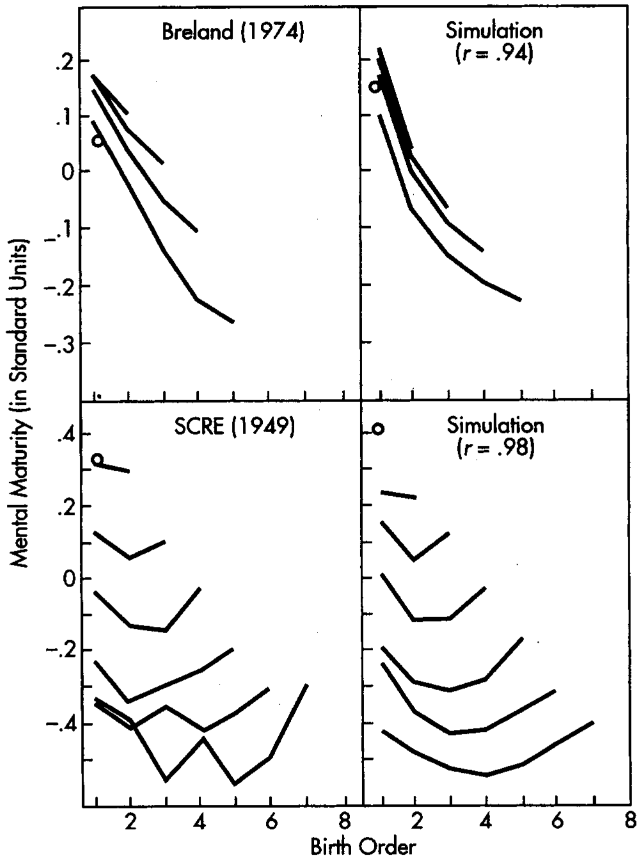
Within-Family Data Confound Birth Order and the Age at Which Children Are Tested

Rodgers et al. (2000) argued that aggregate birth order and family size data cannot be trusted because they "are so filled with potential selection (and other) biases as to be virtually useless" (p. 602). They claimed, as a virtue of their analysis, to rely exclusively on within-family data. However, if researchers test for differences among children within the same family at the same time, the children's ages will differ. Because birth order and family size effects are age specific, instead of conclusive data, a giant confound is created. A within-family analysis of birth order effects requires a longitudinal approach, where children of, for example, 9, 10, 11, 12, 13, 14, and 15 years of age are followed for several years and where, in order to control for period effects, the data for some 9-year-olds are collected at one period, and the data for other 9-year-olds are collected at later periods. This is a laborious project that would realize the virtues of a within-family design.

Cross-Sectional Data Reveal Variations With Age That Within-Family Data Obscure

Cross-sectional data have a useful purpose and can reveal phenomena that within-family designs are incapable of analyzing. I have chosen here a few previously published aggregate cross-sectional data sets. All are explained in great detail by the confluence model, and some offer precise numerical predictions. Figure 2 shows two data sets and the simulation of these data calculated from the reparameterized confluence model (Zajonc & Bargh, 1980b, pp. 350–351).[1] The upper left graph represents the averages of nearly 800,000 scores of 17-year-old candidates for the National Merit Scholarship Qualification Test (Breland, 1974), and to its right are the predicted values for these participants. The lower left graph shows the data on an academic achievement test administered to 70,000 Scottish 11-year-olds (Scottish Council for Research on Education, 1949), and to its right are the corresponding predicted values for these participants. Note that the data for the 17-year-olds show clear birth order and family size effects, with only children not achieving the highest scores but achieving scores about as high as those of the oldest children in three-child families. Note that in contrast, the 11-year-olds show no similar decline in scores with birth order, albeit they show clear family size effects. In both cases, the calculated values are quite close to the observed data (correlations of .94 and .98). The data and the predictions reflect the age specificity of the birth order effect and the decreasing of scores with an increase in family size. The Scottish sample, consistent with the age crossover prediction, also found that only children had the highest scores.

Figure 2
Aggregate Academic Performance Scores (in Standard Units) and Predictions Calculated From the Confluence Model



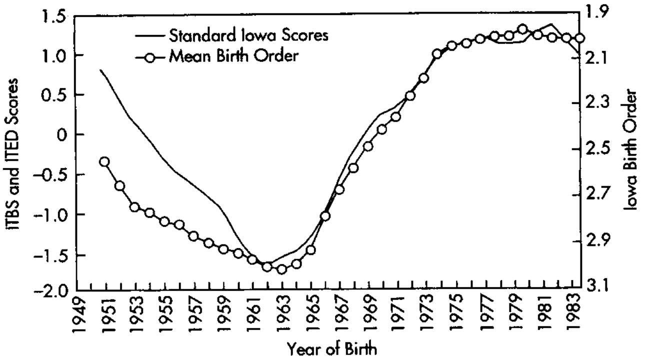
Note. The upper graphs show scores on the National Merit Qualification Test of 800,000 seventeen-year-old candidates (Breland, 1974). The lower graphs show the test scores of 70,000 eleven-year-old school children (Scottish Council for Research on Education [SCRE], 1949).

Only children never become tutors. Thus, although their intellectual environments include just their parents—a condition favoring higher scores—the absence of siblings denies them the benefits of the tutorial function that children with younger siblings enjoy. However, because the advantage of tutoring accrues slowly, only children show the highest scores until their crossover age (i.e., 11 ±2 years), and afterward, their scores drop relative to the top birth ranks. The pattern of data showing that the family size effect is not monotonic, but reaches maximum for families with two children, contradicts a number of theories. For instance, the *dilution theory* (Blake, 1981) attributed the

---

[1] There are four other similar data sets (Zajonc & Bargh, 1980b, pp. 350–351) that I have not included here because of space constraints.

Figure 3
Birth Order and Iowa Basic Skills Scores



Note. The birth order scale is inverted such that higher numerical values represent lower birth ranks. ITBS = Iowa Tests of Basic Skills; ITED = Iowa Test of Educational Development.

decline of intellectual performance with birth order to dwindling resources per child. Downey (2001, this issue) favored the dilution theory mainly because of its simplicity. The fact that the nonmonotonicity of family size effects *contradicts* the dilution theory is dismissed outright. Downey appealed to Blake's conjecture that when there are difficulties with the first birth or with the marriage itself, families decide against a second child. Thus, only children score low on intellectual performance tests because families decide against a second child when the firstborn or the parents' marriage had difficulties. This conjecture, however, is unlikely to be of major importance because it features just one among what must be host of reasons for families having just one child, a circumstance that must apply only to a small minority of families.

Cross-Sectional Data Reveal National Trends That Within-Family Data Are Incapable of Demonstrating

Many other empirical patterns relate academic performance to birth rank—patterns that can be obtained only by using cross-sectional data. For example, the entire school population of Iowa completes proficiency tests in 3rd through 12th grades (ages 9 to 16 years).[2] The U.S. Bureau of the Census (1951–1991) reports the number of births in each state broken down by the number of children previously born to the mother. From these figures, we can readily calculate the average birth order of a given Iowa cohort.[3] Figure 3 shows the average Iowa test scores and the corresponding average birth orders for the cohort years 1951 through 1983. The association between the average order of cohort births and academic performance scores is striking, and similar equally compelling data have also been reported (Zajonc & Mullally, 1997). Within-family analysis would be incapable of revealing secular trends such as those in Figure 3.

Population Trends Show Variations With the Age at Which Children Are Tested

Using the data from the Iowa school proficiency tests and census, I plotted the average scores for each of the 10 grades, together with the average birth orders of these cohorts (see Figure 4). The birth order data are shown in the lower parts of the curves. Note that as predicted by the confluence model, intellectual performance shows no variation with average birth rank when tested before age 11 ±2 years. However, starting with Grade 6 (or age 11 years), a relationship between the average scholastic achievement score and the cohort's birth order emerges and grows more distinct with age. Moreover, the sensitivity of the test scores to the cohort's birth order is striking. The scores reproduce the birth order trends very accurately, with inflection points (i.e., 1963 ±1) for birth order and basic skills scores coinciding. If the analysis had stopped at the fifth grade (i.e., at the crossover age of 11 years), birth order effects would not have been detected.

Within-Family Data and a Massive Rise in National IQs

One important contradiction met by the arguments about the dynamics of family size and intellectual performance has its source in a vast analysis of cross-sectional data by Flynn (1987). If low-IQ parents tend to have large families, then Rodgers et al. (2000) must predict, other things being constant, steady declines in the nation's average IQ, because a giant proportion of IQ variance derives from parental IQ. Yet the opposite is blatantly true. Flynn has shown "massive IQ gains" (p. 171) over the past century—gains of three to seven IQ points per decade in 14 countries. It could be argued that the proportion of large families has declined during this period, thereby allowing average IQ to rise. However, because the IQ rise was extraordinary—one half of a standard deviation per decade—the contribution of the offspring of low-IQ parents would have to have been minuscule. In any event, these secular changes could not have been discovered using within-family data sets.

Conclusion

I have written before about the framing of the birth order question that is presented as an analysis of causes (Zajonc & Mullally, 1997). Rodgers et al. (2000), for example, asked, "do large families cause low-IQ children, or do low-IQ parents make large families" (p. 603)? Birth order and family size are not the sort of variables that translate into causes. They determine nothing in and of themselves.

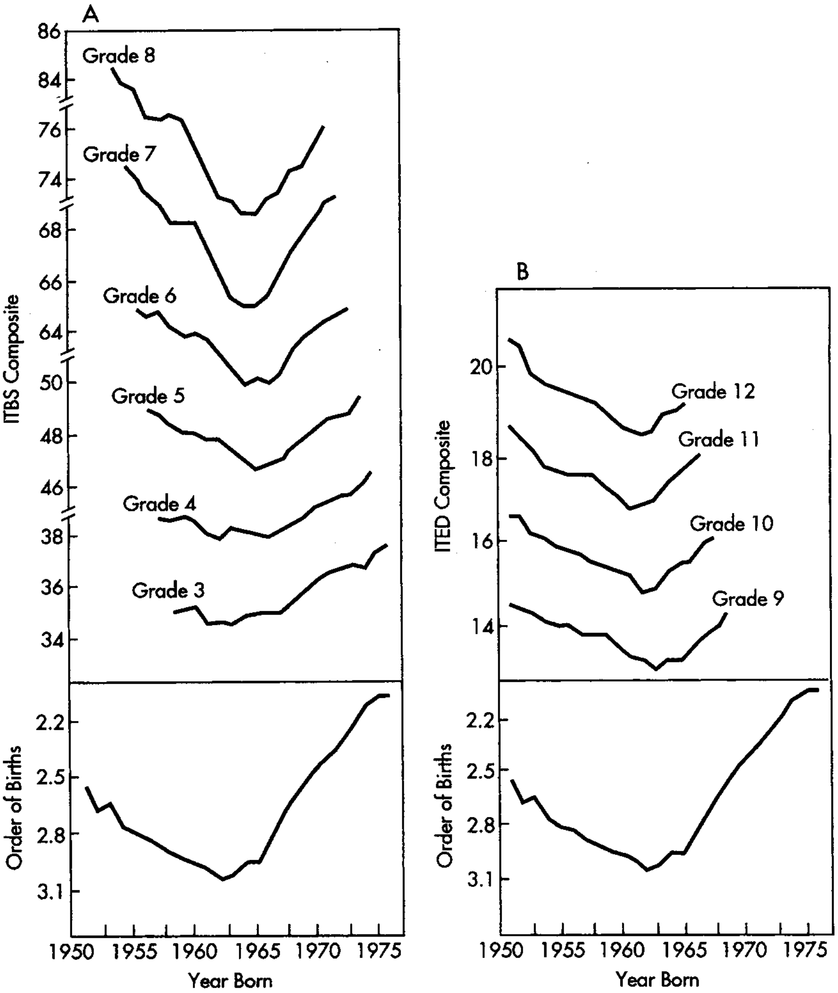
---

[2] The Iowa data were provided by Jim Gould of the State of Iowa Department of Education and Robert L. Brennan, director of the Iowa Testing Program, whom I thank for their help.

[3] I calculated average birth order on the corresponding census data by taking into account children's ages at the time of testing. Thus, for example, if the sixth graders were tested in 1983 (i.e., at age 11 years), then the average birth order for their cohort was calculated on the basis of the 1972 census.

Figure 4

(A) Composite Scores for Iowa Tests of Basic Skills (ITBS; for Grades 3–8 in Iowa) and Aggregate Birth Orders (for Corresponding Cohorts in Iowa), as Well as (B) Composite Iowa Test of Educational Development (ITED) Scores (for Grades 9–12 in Iowa) and Aggregate Birth Orders (for Corresponding Cohorts)



They are conditions that afford, mediate, or prevent an array of diverse outcomes, only one of them being a score on an intellectual performance test. A variety of what seem to be immutable personal attributes, for example, height, gender, skin color, and a host of others, also afford conditions that place members of a society thus characterized in relative advantage or disadvantage. In many societies, height favors leadership opportunities (Young & French, 1998), and gender and skin color dominate access to various scarce social resources, especially power. None of these factors are causes in the essentialist sense of the word. They are features of a social order that has organized institutional structures and behavioral norms for differential distribution of scarce resources, power, and status.

Like these other features, birth order affects differential distribution of society's resources, power, and status. If there is a belief within a culture that such personal attributes as intelligence, leadership, initiative, and so forth are positively associated with birth rank, then social practices and institutions will tend to confirm and reinforce such beliefs. In a recent study, Herrera (2000) asked 203 college students about the hypothetical birth order of various occupations. The correlation between birth rank and occupational prestige (Treiman, 1977) was a robust –.72. The result is far from an illusion; the consequences of gender, race, height, and birth rank differences penetrate people's lives on a real and daily basis.

REFERENCES

Altus, W. D. (1965). Birth order and scholastic aptitude. *Journal of Consulting Psychology, 29,* 202–205.

Arthur, W. D. (1926). The relation of IQ to position in family. *Journal of Educational Psychology, 17,* 541–550.

Belmont, L., & Marolla, F. A. (1973, December 14). Birth order, family size, and intelligence. *Science, 182,* 1096–1101.

Blake, J. (1981). Family size and quality of children. *Demography, 18,* 421–442.

Breland, H. M. (1974). Birth order, family configuration, and verbal achievement. *Child Development, 45,* 1011–1019.

Burton, D. (1968). Birth order and intelligence. *Journal of Social Psychology, 76,* 199–206.

Cicirelli, V. G. (1977). Children's school grades and sibling structure. *Psychological Reports, 41,* 1055–1058.

Claudy, J. G. (1976, August). *Cognitive characteristics, family size, and birth order.* Paper presented at the 84th Annual Convention of the American Psychological Association, Washington, DC.

Davis, D., Cahan, S., & Bashi, J. (1977, June 24). Birth order and intellectual development: The confluence model in the light of cross-cultural evidence. *Science, 196,* 1470–1472.

Douglas, J. W. B. (1964). *The home and the school: A study of ability and attainment in the primary school.* London: Macgibbon & Kee.

Downey, D. B. (2001). Number of siblings and intellectual development: The resource dilution explanation. *American Psychologist, 55,* 497–504.

Eysenck, H. J., & Cookson, D. (1970). Personality in primary school children: 3. Family background. *British Journal of Educational Psychology, 40,* 117–131.

Flynn, J. R. (1987). Massive IQ gains in 14 nations: What IQ tests really measure. *Psychological Bulletin, 101,* 171–191.

Galbraith, R. C. (1982). Sibling spacing and intellectual development: A closer look at the confluence models. *Developmental Psychology, 18,* 181–191.

Herrera, N. C. (2000). *Birth rank and personality: Beliefs and their consequences.* Unpublished doctoral dissertation, Stanford University, Stanford, CA.

Hsiao, H. H. (1931). The status of the first-born with special reference to intelligence. *Genetic Psychology Monographs, 9,* 43–115.

Institut National d'Etudes Démographiques. (1973). *Enquête nationale sur le niveau intellectuel des enfants d'âge scolaire* [National survey of intellectual level of school-age children]. Paris: Author, with Presses Universitaire de France.

Koch, H. L. (1954). The relation of "primary mental abilities" in five- and six-year-olds to sex of child and characteristics of his sibling. *Child Development, 25,* 209–223.

Kunz, P. R., & Peterson, E. T. (1977). Family size, birth order, and academic achievement. *Journal of Social Psychology, 245,* 144–148.

Page, E. B., & Grandon, G. M. (1979). Family configuration and mental ability: Two theories contrasted with U.S. Data. *American Educational Research Journal, 16,* 257–272.

Richardson, S. K. (1936). The correlation of intelligence quotients of siblings at the same chronological age levels. *Journal of Juvenile Research, 20,* 186–197.

Rodgers, J. L., Cleveland, H. H., van den Oord, E., & Rowe, D. C. (2000). Resolving the debate over birth order, family size, and intelligence. *American Psychologist, 55,* 599–612.

Rosenberg, B. G., & Sutton-Smith, B. (1969). Sibling age spacing effects upon cognition. *Journal of Developmental Psychology, 1,* 661–668.

Schachter, S. (1963). Birth order, eminence and higher education. *American Sociological Review, 28,* 757–768.

Schooler, C. (1972). Birth order effects: Not here, not now! *Psychological Bulletin, 78,* 161–175.

Scottish Council for Research on Education. (1949). *The trend of Scottish intelligence.* London: University of London Press.

Steckel, M. L. (1930). Intelligence and birth order. *Journal of Social Psychology, 1,* 329–344.

Steelman, L. C., & Mercy, J. A. (1980). Unconfounding the confluence model: A test of sibship size and birth order effects on intelligence. *American Sociological Review, 45,* 571–582.

Sulloway, F. (1996). *Born to rebel: Birth order, family dynamics, and creative lives.* New York: Pantheon Books.

Svanum, S., & Bringle, R. G. (1980). Evaluation of confluence model variables on IQ and achievement test scores in a sample of 6- to 11-year-old children. *Journal of Educational Psychology, 72,* 427–436.

Tabah, L., & Sutter, L. (1954). Le niveau intellectuel des enfants d'une même famille [The intellectual level of children of the same family]. In *Le niveau intellectuel des enfants d'âge scolaire.* Paris: Institut National d'Etudes Démographiques, with Presses Universitaire de France.

Treiman, D. J. (1977) *Occupational prestige in comparative perspective.* New York: Academic Press.

U.S. Bureau of the Census. (1951–1991). *Natality report.* Washington, DC: U.S. Government Printing Office.

Velandia, W., Grandon, G. M., & Page, E. B. (1978). Family size, birth order, and intelligence in a large South American sample. *American Educational Research Journal, 15,* 399–416.

Young, T. J., & French, L. A. (1998). Heights of U.S. presidents: A trend analysis for 1948–1996. *Perceptual and Motor Skills, 87,* 321–322.

Zajonc, R. B. (1976, April 16). Family configuration and intelligence. *Science, 192,* 227–236.

Zajonc, R. B. (1983). Validating the confluence model. *Psychological Bulletin, 93,* 457–480.

Zajonc, R. B., & Bargh, J. (1980a). Birth order, family size, and decline of SAT scores. *American Psychologist, 35,* 662–668.

Zajonc, R. B., & Bargh, J. (1980b). The confluence model: Parameter estimation in six divergent data sets on family factors and intelligence. *Intelligence, 4,* 349–361.

Zajonc, R. B., Markus, H., & Markus, G. B. (1979). The birth order puzzle. *Journal of Personality and Social Psychology, 37,* 1325–1341.

Zajonc, R. B., & Mullally, P. R. (1997). Birth order: Reconciling conflicting effects. *American Psychologist, 52,* 685–699.