production (Fig. 2a) compared with the intact controls (ten animals).

In another series of experiments on six animals, the sympathetic trunks in the neck were stimulated electrically on both sides by two pairs of platinum wire electrodes that were fixed with an uninsulated loop around the nerve trunks immediately below the superior cervical ganglia. After reaching the steady state in perfusion required to calculate normal flow, the cervical sympathetics were stimulated intermittently (stimulation on 30 seconds, off 30 seconds) during 1 to 2 hours with monopolar square waves (3 to 10 V; pulse duration, 2 msec; frequency, 15 Hz). The sympathetic activation produced a reduction in the rate of CSF formation by a mean of 32 percent compared with the control situation before stimulation (Fig. 2b). After cessation of the stimulation, the radioactivity in the effluent adjusted to a new plateau level from which it could be calculated that the CSF flow rate returned approximately halfway (49 percent) toward normal during the 1-hour period after stimulation (Fig. 2b). Each train of 30-second stimulation sometimes caused a transient insignificant reduction in systemic blood pressure (by, at most, 10 mm-Hg), probably due to inadvertent stimulation of the vagus nerve or nerves. During the entire stimulation period there was usually a progressive slight fall in the infusion pressure (which, under the condition of the constant inflow and outflow rates, reflects intraventricular pressure) by a maximum of 25 mm-H_2O.

The studies have shown that the rabbit choroid plexus receives a well-developed adrenergic nerve supply originating almost entirely from the superior cervical sympathetic ganglia. The nerves appear to have an inhibitory effect on bulk CSF production, a situation thus resembling the sympathetic inhibition of the aqueous humor formation from the ciliary body (*10*). This is consistent with the observation that cervical sympathectomy (or intraventricular administration of reserpine) markedly increases ventricular fluid pressure to a level that is even lethal if CSF outflow pathways have been blocked by cisternal injection of kaolin (*11*). Since the sympathetic nerve terminals in the plexuses innervate both the local vascular bed and the secretory epithelium, the effect on CSF production may have been mediated through changes in plexus blood flow as well as through direct effects on the secretory cells. It is unlikely that a primary action on plexus blood flow would account for the very marked changes in CSF production observed, and there is also experimental evidence that the marked increase in cerebral blood flow associated with moderate hypercapnia does not enhance the rate of CSF production (*12*). Moreover, the increase in carbonic anhydrase activity of the plexus epithelium found after sympathetic denervation (*7*) favors a prominent direct effect of adrenergic nerves on the plexus epithelium and its secretory functions.

It is concluded that the sympathetic nerves in the choroid plexus have an inhibitory function on bulk CSF production by a control exerted primarily on the plexus epithelium.

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References and Notes

1. H. Davson, *Physiology of the Cerebrospinal Fluid* (Little, Brown, Boston, 1967); H. F. Cserr, *Physiol. Rev.* **51**, 273 (1971).
2. M. Benedikt, *Virchows Arch. Pathol. Anat.* **59**, 395 (1874); E. C. Crosby, T. Humphrey, E. W. Laner, *Correlative Anatomy of the Nervous System* (Macmillan, New York, 1962), pp. 1–731; J. W. Millen and D. H. M. Wollam, *The Anatomy of the Cerebrospinal Fluid* (Oxford Univ. Press, London, 1962), pp. 1–151.
3. J. W. Millen and G. E. Rogers, *J. Biophys. Biochem. Cytol.* **2**, 407 (1956); V. M. Tennyson and G. D. Pappas, *Prog. Brain Res.* **29**, 63 (1968).
4. S. R. Heisey, D. Held, J. R. Pappenheimer, *Am. J. Physiol.* **203**, 775 (1962); J. R. Pappenheimer, S. R. Heisey, E. F. Jordan, J. De C. Downer, *ibid.*, p. 763.
5. Å. Bertler, A. Carlsson, E. Rosengren, *Acta Physiol. Scand.* **44**, 273 (1958); A. Björklund, B. Falck, Ch. Owman, in *Methods of Investigative and Diagnostic Endocrinology*, S. A. Berson, Ed. (North-Holland, Amsterdam, 1972), vol. 1, pp. 318–368; J. Häggendal, *Acta Physiol. Scand.* **59**, 242 (1963).
6. L. Edvinsson, K. C. Nielsen, Ch. Owman, K. A. West, *Am. J. Anat.* **139**, 299 (1974); M. Lindvall, L. Edvinsson, Ch. Owman, *Exp. Neurol.* **55**, 152 (1977).
7. L. Edvinsson, R. Håkanson, M. Lindvall, Ch. Owman, K.-G. Svensson, *Exp. Neurol.* **48**, 241 (1975).
8. The artificial CSF buffer solution had the following composition (in millimoles per liter): NaCl, 123; $CaCl_2$, 0.86; KCl, 3.0; $MgCl_2$, 0.89; $NaHCO_3$, 25; NaH_2PO_4, 0.50; Na_2HPO_4, 0.25; it was gassed with 5 percent CO_2 in O_2.
9. The figures agree with the normal values obtained in spontaneously respirating rabbits [R. Sercombe, P. Aubineau, L. Edvinsson, H. Mamo, Ch. Owman, E. Pinard, J. Seylaz, *Neurology* **25**, 954 (1975)].
10. H. Davson, *The Physiology of the Eye* (Churchill Livingstone, London, 1972).
11. L. Edvinsson, Ch. Owman, K. A. West, *Acta Physiol. Scand.* **83**, 42 (1971); *ibid.*, p. 51; L. Edvinsson, K. C. Nielsen, Ch. Owman, K. A. West, *J. Neurosurg.* **40**, 743 (1974).
12. W. W. Oppelt, T. H. Maren, E. S. Owens, D. P. Rall, *Proc. Soc. Exp. Biol. Med.* **114**, 86 (1963); A. N. Martins, T. F. Doyle, N. Newby, *Am. J. Physiol.* **231**, 127 (1976).
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A Fertility Reaction to a Historical Event: Southern White Birthrates and the 1954 Desegregation Ruling

Abstract. *On 17 May 1954 the Supreme Court, in its decision in* Brown v. Board of Education, *declared de jure segregation of the public schools to be unconstitutional. It is argued here that a consequence of that decision was a decline in childbearing among white Southerners. In the nation as a whole, period fertility rates increased between 1954 and 1955, but in 9 of the 11 former Confederate states they decreased. Further analysis shows that these Southern fertility decreases began about 12 months after the Supreme Court decision. This variation in behavior in reaction to a historical event has important implications for the explanation and prediction of fertility.*

At a time in the 1950's when the overall U.S. birthrate was increasing sharply, the states of the South (*1*) displayed a markedly lower increase, thereby closing, even reversing, a longstanding regional difference in fertility (*2*). The most marked convergence between the entire South and the remainder of the country occurred between 1954 and 1955 (Fig. 1). This one sharp shift is the subject of this report; the long-range change also seen in Fig. 1 is discussed elsewhere (*2*).

Because these fertility rates were computed from sample data from the 1960 and 1970 censuses, the shift in 1954–55 was originally dismissed as being due to random variation. However, further inspection revealed that the same pattern exists in the total number of births actually registered. We examined reported vital registration data for whites and blacks. In the South the number of white births increased faster than in the nation as a whole between 1953 and 1954 (2.2 percent in the South, 0.8 percent nationally) but declined by 0.7 percent between 1954 and 1955, while the national figure was increasing by 1.9 percent. Between 1955 and 1956 the number of white births increased again in the South (by 2.2 percent), but more slowly than in the nation as a whole (the national increase was 2.6 percent). In 1955, 23 of the 32 non-Southern states had more white births than in 1954, whereas only 4 of the 16 Southern states did. The year before, 28 of the non-Southern states and 14 of the Southern states had shown increases.

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The pattern of black births was similar but less pronounced.

Aberrant behavior in the South in the year 1954 is likely to suggest its own explanation to those familiar with the recent history of the region. On 17 May 1954 the Supreme Court rendered its decision in *Brown v. Board of Education*, declaring public school segregation to be unconstitutional. It is clear that the court's unanimous decision struck at what many white Southerners saw as the basis of their region's way of life, and that it came as a shock to many Southerners (*3*). It seems reasonable, therefore, to entertain the conjecture that anomie and fear for the future led some Southerners to put off having children who would otherwise have been conceived during this period (*4*). First, the timing was right, roughly speaking: the effects of events in May and the summer of 1954 would not show up in birth figures until 1955. Second, the slighter drop among blacks seems consistent with the hypothesis: while black Southerners also experienced uncertainty in the wake of the court's ruling (their traditional pattern of education was threatened, and undoubtedly they feared that violence might accompany desegregation), obviously the status and prerogatives of white Southerners were more clearly threatened.

Table 1 shows the pattern of change in numbers of births (*5*) in relation to the existence of segregated schools. Of the 11 former Confederate states, all of which are included in almost any definition of the South, only two—North Carolina and Florida—had an increase in white births between 1954 and 1955. (Nine of the 11 had had an increase the year before, and nine had an increase the next year.) Six other states and the District of Columbia also required school segregation in 1954, but most of these had relatively small black populations and were less affected by the court's ruling. Three of these six states and the District of Columbia had fewer white births in 1955 than in 1954, and three had more. (In 1954 only the District of Columbia had fewer white births than in 1953. In 1956 only the District and Kentucky had fewer than in 1955.) Of the 31 other states 22 had more white births in 1955 than in 1954: of the nine exceptions, three—Pennsylvania, Indiana, and Kansas (the state in which the *Brown* case originated)—had a noticeable degree of school segregation at the local level (*6*). (In 1954, 27 of the 31 had more white births than in 1953; in 1956, 22 had more than in 1955.)

We also compared 1954 and 1955 births grouped according to age of mother and to birth order of child. In every age group the ratio of the number of births in 1955 to the number of births in 1954 was less in the former Confederate states and the other states with dual school systems than in the remainder of the country. The same is true for birth order, with one exception. Among all the groups of states there were declines in the number of second births in 1955 from the number in 1954, and the decline was slightly larger among the other states than in either group of dual-system states.

Table 1. Direction of change in number of white births between 1954 and 1955 in states with dual school systems and in the other states (*5*).

State group	Number of states with	
	Increase	Decrease
Former Confederate states	2	9
Other dual-system states*	3	4
Remaining states	22	9

*The District of Columbia is included here.

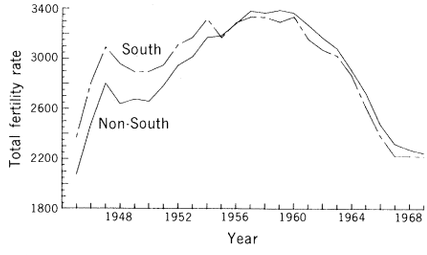

Fig. 1. Total fertility rates of Southern and non-Southern women, 1945–1969. The total fertility rate is the number of children 1000 women of childbearing age would be predicted to give birth to in their lifetimes if the fertility rate of the base period remained unchanged. [Figure courtesy of *Social Forces*]

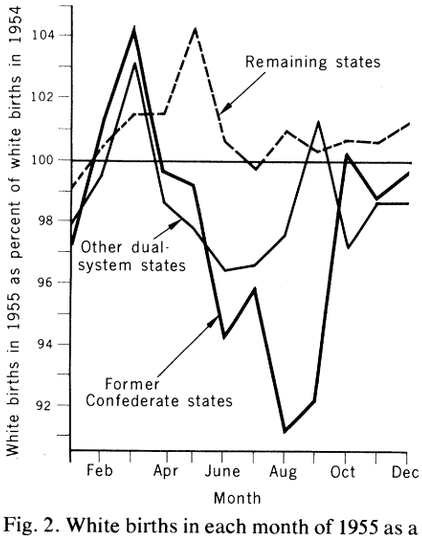

Fig. 2. White births in each month of 1955 as a percentage of white births in the same months of 1954, in states with dual school systems and in the other states.

These differences between the states affected by the *Brown v. Board of Education* decision and those not affected by the decision do not in themselves, of course, establish a cause-and-effect relation. Yet it is a striking coincidence, and one that gets more striking when we look at month-by-month data.

The earliest one could possibly expect to see any effect the ruling might have on fertility would be in early spring 1955. Some couples who had not been practicing contraception may have begun to do so immediately after the Supreme Court decision. Some couples who had planned to stop using contraception in order to have a baby may have decided not to stop. In either case the effect on subsequent fertility levels would be gradual because of the time required to conceive in the absence of deliberate contraception. Also, it can be assumed that these hypothetical decisions would not have been made the day after the Supreme Court's decision, that it took a while for the implications of the decision to sink in. Finally, after it became clear that segregation would continue for some time, that life would go on much as usual, that "all deliberate speed" could be very deliberate, that Southern politicians had some resources of their own to resist with—in other words, when it became clear that nothing much was going to change any time soon—our hypothetical couples would have resumed their normal fertility behavior and the Southern white birthrate would resume its increase. Thus, the major depression in Southern white birthrates in reaction to the Supreme Court decision would be expected to occur in the late spring or early summer of 1955 and to terminate shortly thereafter.

In Fig. 2 we have plotted for the three groups of states discussed above the number of white births in each month of 1955 expressed as a percentage of the number in the same month in 1954. This statistic, though crude, removes seasonal variation in birthrates (including variation due to differences in the number of days in a month) and any interaction of that variation with region (*7*). In both sets of states with segregated schools we find a decrease in the number of white births which may have begun in late spring and early summer. In the summer both sets of states with segregated schools experienced lower fertility than

the year before, but that is not the case in the remainder of the United States. By the end of fall this depression in number of births relative to the previous year was essentially over in both groups of dual-system states. The reduction was somewhat greater and lasted somewhat longer in the former Confederate states than in the other group, as would be expected.

The pattern of month-by-month variation within individual states further supports the evidence of Fig. 2. In order to reduce chance variation, we examined only the 34 states that averaged more than 2000 white births per month during this period. Of these, 16 were dual-system states. All but 2 of the 16 had fewer white births during the late spring and early summer of 1955 than in 1954. That was true of only 7 of the 18 unitary-system states, 6 of the 7 being states that border on one or more former Confederate states or other dual-system states.

In other words, we find the number of white births in the South to be lower than expected at almost the exact time we would predict, assuming the *Brown* decision demoralized prospective parents enough to cause some who would otherwise have stopped contracepting to continue and to cause others who had not been contracepting to start using contraception. The deflection is short-lived: it is concentrated in a period of 3 or 4 months. It is not large: Southern white birthrates were reduced by something on the order of 5 percent (*8*).

But even this small deflection is of considerable historical interest, if one accepts our explanation of it. It may, in addition, have some implications beyond that—implications for the study of fertility trends elsewhere in the developed world, and implications about the ability of social scientists to explain and predict such trends. Within the United States, for instance, since World War II there have been large, unprecedented, and unpredicted changes in fertility behavior, changes with significant consequences for many institutions in American society. The fact that these changes have been found within every social, economic, and racial group (*9*) suggests that they cannot be accounted for by changes in the composition of the population and that their explanation must be linked to historical events.

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References and Notes

1. The "South" here is the "census South," which includes the 11 former Confederate states, plus Delaware, Maryland, West Virginia, Kentucky, Oklahoma, and the District of Columbia.
2. R. R. Rindfuss, *Soc. Forces*, in press.
3. White Southern opposition to the decision hardly needs documenting, but it may be noted here that in a sample survey 2 years after the Court's ruling only 14 percent of white residents of the census South expressed support for school desegregation [H. R. Hyman and P. B. Sheatsley, *Sci. Am.* **211** (No. 7), 16 (1964)].
4. Psychological stress can trigger physiological subfecundity by blocking the release of luteinizing hormone necessary for ovulation [L. Mastroianni, in *Gynecology and Obstetrics*, S. L. Romney *et al.*, Eds. (McGraw-Hill, New York, 1975)]. It can also reduce male potency. But we are not suggesting that the *Brown* decision had those effects.

   We considered current events other than the court's decision as alternative explanations for the decline in Southern fertility. These ranged from Hurricane Hazel to the possibility of a short-run economic downturn in the South. However, after further reflection and investigation none of these alternative explanations seemed plausible.
5. This table is based on the absolute number of white births—in other words, on the numerator of a conventional fertility rate (the denominators are not available for individual states). This statistic is unsatisfactory in many applications [see, for example, M. Gomez B. and J. Reynolds, *Stud. Fam. Plann.* **4**, 317 (1973)], but it is unlikely that the three regions' denominators changed appreciably (and differently) in the short time span involved.
6. Of the other six, five were small states which exhibit considerable fluctuations in numbers of births from year to year: Idaho, Maine, North Dakota, Rhode Island, and Wyoming.
7. It has been suggested that the denominators for the data in Fig. 2 be based on a 3-year average rather than a single year. We have done this calculation; the differences between the dual-system states and the rest of the country are similar to those in Fig. 2 but less pronounced. However, using a 3-year average increases the problems involved in numerator analysis (*5*). The 3-year average may conceal substantial and differential changes brought about by the substantial migration from the South. Using only the preceding year minimizes this effect. Also, the effect of the upward fertility trend of the early 1950's is less with a 1-year base than with a 3-year average.
8. One should expect an effect like this not to be large. A deflection much greater than that observed would be, literally, incredible. The seasonally adjusted number of births in the former Confederate states for June 1955 was slightly more than 2 standard deviations below the average number of births (seasonally adjusted) in those states for the previous 13 months. (June was chosen because it represents the approximate beginning of a substantial deflection. If August or September had been chosen, the difference would be greater.) Alternatively, it is rather unlikely that the two groups of dual-system states would show declines for April, May, June, and July of 1955 (relative to the same months the previous year) while the rest of the country experienced increases, if chance variation were the only factor at work. Perhaps we should note that neither the Box-Tiao test [G. E. P. Box and G. C. Tiao, *Biometrika* **52**, 181 (1965)] nor the variation proposed by Glass [G. V. Glass, *Law Soc. Rev.* **3**, 55 (1968)] is appropriate here, because we are predicting a temporary change rather than a permanent one.
9. R. R. Rindfuss and J. A. Sweet, *Postwar Fertility Trends and Differentials in the United States* (Academic Press, New York, 1977).
10. Supported in part by a grant from the Carolina Population Center of the University of North Carolina. We thank Judy Kovenock for assistance in programming.

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Enhanced Dexamethasone Resistance in Cystic Fibrosis Cells: Potential Use for Heterozygote Detection and Prenatal Diagnosis

Abstract. *Cultured skin fibroblasts from patients with cystic fibrosis (CF) are more resistant to dexamethasone toxicity than are normal cells. We now report that, when fibroblasts cultured from obligate CF heterozygotes are exposed to dexamethasone, they have an intermediate survival compared to normal and homozygous CF cells. When dexamethasone survival was tested on cells from four patients undergoing amniocentesis, cells from a woman at risk of producing a child with CF showed significant dexamethasone resistance, similar to that of fibroblasts derived from known CF homozygotes; the other amniotic cell specimens showed dexamethasone sensitivity similar to that of normal skin fibroblasts. These data suggest that the dexamethasone resistance previously observed in skin fibroblasts may also be useful in the prenatal diagnosis of CF.*

Cystic fibrosis (CF) is the most common autosomal recessive disease among Caucasians, occurring once in every 1600 to 2500 live births. The clinical manifestations of the disease most commonly involve the pulmonary and gastrointestinal systems, resulting in a mean life expectancy for these patients of less than 21 years (*1, 2*). Although diagnosis of CF is aided by the finding of abnormally high concentrations of sodium and chloride ions in the sweat of affected individuals, the basic biochemical defect responsible for the disease is not yet known. In addition, there is no currently accepted method for detecting heterozygotes for CF or for making a prenatal diagnosis of the disease. In studies of skin fibroblasts cultured from many different individuals with CF, we observed that CF cells were more resistant to the cytotoxic effects of dexamethasone, a synthetic glucocorticoid, than normal fibroblasts were (*3*). We have also shown that CF cells exhibit cross-resistance to ouabain and the sex steroids, drugs whose molecular structures are similar to that of dexamethasone (*4, 5*). In each case, the resistance of CF cells to these drugs has not been due to any of the mechanisms commonly responsible for resistance to any single drug (*5, 6*).

We have now examined skin fibroblasts cultured from patients with CF

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