

Genetics of Educational Attainment in Australian Twins: Sex Differences and Secular Changes

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Received 23 Aug. 1993—Final 15 Aug. 1995

The relative effects of genetic and environmental factors in producing individual differences in educational achievement are compared across women and men and over birth cohorts. In a large sample of Australian twin pairs, the heritability of self-reported educational attainment did not vary among women and men born before and after 1950. In a "psychometric" model of twin resemblance, based on separate self-reports in 1981 and 1989, genetic factors explained 57% of the stable variance in educational achievement, while environmental factors shared by twins accounted for 24% of the variance. Corrections for phenotypic assortative mating for educational level, however, suggested that estimated common-environmental effects could be entirely explained by the correlation between additive genetic values for mates. Taking this into account, heritability of "true" educational attainment in Australia may be as high as 82% with the remaining variation being due to individual environments or experiences. Unlike previous studies in Scandinavian countries, results in Australia suggest that factors influencing educational success are comparable between women and men and for individuals born at different points during this century.

KEY WORDS: Educational attainment; Australian twins; sex differences; secular changes.

INTRODUCTION

Comparing the relative effects of underlying genetic and environmental factors on educational attainment for women and men and over time can provide insight into the effects of social policy on groups of individuals. Attempts to provide equal educational opportunities to individuals within a population, if successful, should lead to more uniform environmental factors, and thus a greater rel-

ative genetic variation (i.e., heritability) (Scarr-Salapatek, 1971). As social policies change over time, or are applied differentially to different subgroups such as women and men or various social classes, different heritabilities should become apparent between these subgroups and/or over time.

Educational attainment is a phenotype that has been affected in Western society by several sociopolitical events in this century such as wars, changes in civil rights policies, changing reproductive practices associated *inter alia* with the introduction of the birth control pill, and the legalization of abortion. Changes in average levels of schooling have been apparent over the last 75 years, for both women and men, in most Western countries, including Australia (Castles, 1992a). Nonetheless, considerable individual differences within both sexes have continued to be apparent throughout this

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century. The causes of these individual differences, and how these causes may have changed over time for both women and men, are the focal points of this paper. To address both secular changes and sex differences, the relative impacts of genes and environment on educational attainment are studied in a large sample of female and male Australian twins born between 1893 and 1965.

There is already considerable evidence for the effects of genetic variation on educational attainment in men across various countries and birth cohorts. In an adoption study of Danish brothers (born between 1938 and 1947), heritable influences accounted for 68% of the variance, while shared family environmental factors explained another 27% of the variance in educational level reached between 18 and 26 years of age (Teasdale and Owen, 1984). In a joint analysis of parents and offspring, spouses, siblings, and MZ and DZ twins from several American twin and family studies, Vogler and Fulker (1983) have reported a heritability (h^2) of .56 for educational attainment in males (born primarily before 1945). Although there were also effects of environmental factors shared by siblings (explaining 19% of variation in twins and 21% of variation in nontwins), environmental transmission from parents to offspring was negligible. In a Norwegian sample of male twins, substantial heritable variation in educational achievement was also found for those born after 1935 ($h^2 = .51$). However, genetic effects were reported to be considerably lower ($h^2 = .10$) and shared twin environmental variation higher ($c^2 = .62$) in men born before 1935 (Tambs *et al.*, 1989). Thus, some secular changes in heritable influences in educational achievement may be apparent, at least in men.

There have been marked differences between educational attainments in women compared to men, although women's gains during this century (and even in the last decade) have reduced these mean differences considerably [see Castles (1992a) regarding these changes in Australia]. In spite of this, scant attention has been paid to the relative effects of genetic and environmental factors in women. One notable exception is the study of Norwegian twins, where Heath *et al.* (1985) examined both secular changes and sex differences in heritability and shared environmental factors. Although heritability for educational level was comparable for women and men born before 1940 ($h^2 = .41$),

the relative impact of genetic factors increased dramatically for men ($h^2 = .67-.74$) but not for women ($h^2 = .38-.45$) born after 1940. These findings have been taken to imply that social policy affecting educational reforms after World War II have led to more (innate) ability-related success for men. Conversely, family environmental factors still play a major role in the educational success of Norwegian women, rather than genetically based individual differences. Heath *et al.* discussed the possibility that educational reforms in Norway may have led to more equal opportunities (i.e., less environmental variation) for men, but not for women born in the later part of this century.

The provocative findings in Norwegian twins led us to examine sex and cohort differences in genetic and environmental influences in the Australian educational system. Although there are many worldwide economic and political factors which may have influenced Norwegian and Australian societies in parallel, there are additional factors specific to Australia which may have influenced its educational system independently of that in Norway. For example, legislation between 1870 and 1900 was enacted to ensure that the government should provide compulsory, free, and secular education to its residents. Major changes in the Australian educational system since that time have primarily corresponded to increasing participation in private schooling, and the contribution of state funds to nonpublic schools, which has been legal in Australia since the late 1950s (see Anderson, 1993). Thus, the provision of equal access to education for all individuals in Australia since the turn of this century may suggest that heritable variation of educational attainments will be greater in older birth cohorts in Australia compared to Norway. Other factors which may have differentially affected women's and men's educational attainments throughout this century (e.g., sex-role attitudes) may lead to different effects of environmental and genetic variations in the two sexes.

METHOD

Subjects. The present study is based on a sample of 3808 pairs of Australian twins who participated in an initial mail survey in 1981, which included questions about their educational achievements (see Jardine *et al.*, 1984). From this total sample, 83.1% of the individuals ($n = 6327$) com-